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103rd Scientific Assembly and Annual Meeting
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McCormick Place, Chicago
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SSA01

Breast Imaging (Multimodality Screening and Breast Density)

Sunday, Nov. 26 10:45AM - 12:15PM Room: Arie Crown Theater

BR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Colleen H. Neal, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose
Liane E. Philpotts, MD, New Haven, CT (*Moderator*) Consultant, Hologic, Inc

Sub-Events

SSA01-01 Discordant Interpretation of Screen-Detected Cancers Using Tomosynthesis and Independent Double Reading in a Population-Based Mammography Screening Program

Sunday, Nov. 26 10:45AM - 10:55AM Room: Arie Crown Theater

Participants
Per Skaane, MD, PhD, Oslo, Norway (*Presenter*) Equipment support, Hologic, Inc Consultant, Hologic, Inc Support, Hologic, Inc
Randi Gullien, RT, Oslo, Norway (*Abstract Co-Author*) Support, Hologic, Inc; Travel support, Hologic, Inc
Bjorn Helge Osteras, MSc, Oslo, Norway (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Analyze missed screening cancers (SDC) with tomosynthesis (DBT) using independent double reading in population-based screening

METHOD AND MATERIALS

Trial was approved by Ethical Committee. Participating women signed a written consent. 24,301 women age 50-69 undergoing FFDM+DBT were included. The trial had 4 arms A-D: A=FFDM,B=FFDM+CAD,C=FFDM+DBT, D=syn2D+DBT. Reading was performed in batch mode using a 5-point rating scale. 8 readers participated alternating between reading modes. Scores 1 (neg) and 2-5 (pos) were stored directly into the national screening database. Cases with positive score by at least one reader were discussed at arbitration meeting before final decision for recall. There was automated recording of all reading times directly into the screening database. For purpose of this analysis, mainly the two arms C-D including DBT were analyzed.

RESULTS

230 SDC were diagnosed: 3 cancers in arm A+B only, 172 cancers in both main arms A+B and C+D, and 55 cancers in arm C+D only (detection rate 2D=175 or 7.2/1000 vs. 2D+3D=227 or 9.3/1000, p<0.001). Among SDC in both main arms, discordant rate (cancer missed by one reader) was 50/172 (29%) for arms A-B and 41/172 (24%) for arms C-D. Discordant rate for DBT-only was 30/55 (55%). Discordant cancers for arms C-D among the 172 SDC included spiculated mass or distortion in 17/41 (41%) and in 21/30 (70%) for DBT-only cases. Discordance for microcalc's only was 16/41 (39%) and 2/30 (7%), respectively. Median reading time for exams with negative score by all 4 readers (n=20,106) was: Arm A 25 sec, arm B 28 sec, arm C 62 sec (range 36-170), and arm D 58 sec (range 36-156). For the 55 DBT-only detected cancers, median reading time for TP's in arm C-D was 229 and 217 sec compared with 70 and 59 sec for FN's, respectively. 4/6 (67%) of SDC among the 30 discordant DBT-only cancers with less than 45 sec reading time presented as spiculated mass or distortion. The TP rate (detected cancers among all read) for arms C-D for individual readers varied from 7% to 39%. The radiologist with shortest reading time missed most cancers.

CONCLUSION

Discordant interpretation is a challenge in screening including use of DBT, and subtle cancers presenting as spiculations might easily be missed at DBT using batch reading

CLINICAL RELEVANCE/APPLICATION

Subtle cancers manifesting with spiculations might easily be overlooked. Training and careful reading might reduce number of missed small cancers

SSA01-02 Breast Density Comparison Between Synthesized Versus Full Field Digital Mammography

Sunday, Nov. 26 10:55AM - 11:05AM Room: Arie Crown Theater

Awards
Student Travel Stipend Award

Participants
Irfanullah Haider, MD, MBA, SALT LAKE CITY, UT (*Presenter*) Nothing to Disclose
Matthew B. Morgan, MD, Sandy, UT (*Abstract Co-Author*) Consultant, Reed Elsevier
Anna K. McGow, MD,MBA, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose

Matthew Stein, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
Maryam Rezvani, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
Nan Hu, PhD,MS, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
Laurie L. Fajardo, MD, MBA, Park City, UT (*Abstract Co-Author*) Consultant, Hologic, Inc Scientific Advisory Board, Hologic, Inc Consultant, Koninklijke Philips NV Advisory Board, Koninklijke Philips NV Consultant, Siemens AG Consultant, FUJIFILM Holdings Corporation Advisory Board, Galena Biopharma, Inc
Nicole S. Winkler, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate perceptual difference in breast density classification using synthesized mammography (SM) compared to full field digital mammography (FFDM) for screening mammography.

METHOD AND MATERIALS

This institutional review board approved retrospective multi-reader study evaluated breast density on 200 patients who underwent baseline screening mammogram during which both SM and FFDM were obtained from 6/1/2016 through 11/30/2016. Qualitative breast density was independently assigned by 7 readers (blinded to each other) initially viewing FFDM alone. Then, in a separate session, these readers assigned breast density using synthetic views alone on the same 200 patients and were again blinded to each other's assignment. Qualitative density assessment was based on Breast Imaging Reporting and Data Systems (BI-RADS) 5th Edition. Generalized linear mixed effects model (GLMEM) was used to evaluate the association of breast density between SM and FFDM taking into account random variation by controlling for age and breast thickness on breast density classification and readers. Odds ratios (ORs) and their 95% confidence intervals (CIs) were then calculated for these variables.

RESULTS

The OR for denser breast classification in SM versus FFDM was 0.581 (95% CI: 0.460, 0.733; p-value < 0.0001) demonstrating a statistically significant denser breast assignment on SM compared to FFDM per patient across the readers. Raw data analysis shows 81.8% had no change in density assignment between SM and FFDM, 6.3% were higher density in FFDM though 11.9% had a higher density assigned in SM. The OR for compressed breast thickness was 1.26 (p=0.01) reflecting generally lower density in thicker breasts. The OR for age was 1.47 (p-value < 0.001) reflecting higher density BIRADS classification in younger women.

CONCLUSION

SM is associated with a higher qualitative breast density BI-RADS assessment compared to FFDM resulting in a higher likelihood of assigning a greater density classification in SM compared to FFDM.

CLINICAL RELEVANCE/APPLICATION

Synthesized mammography (SM) is increasingly replacing full field digital mammography (FFDM), but its impact on qualitative breast density classification has not been studied. Density assessment is important as it conveys information regarding cancer risk and accuracy of mammography, which may alter decisions about adjunctive imaging, therefore determining whether assessment differs between SM and FFDM is important.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Maryam Rezvani, MD - 2015 Honored Educator

SSA01-03 The Relationship between Quantitative Breast Density, Age and Cancer Detection Rate in a Large UK Breast Screening Population

Sunday, Nov. 26 11:05AM - 11:15AM Room: Arie Crown Theater

Awards
Student Travel Stipend Award

Participants
Sam Dumonteil, MBBS,FRCR, London, United Kingdom (*Presenter*) Nothing to Disclose
Louise S. Wilkinson, MBBCh, FRCR, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Elizabeth S. Burnside, MD, MPH, Madison, WI (*Abstract Co-Author*) Nothing to Disclose
Samantha L. Heller, MD, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Sue Hudson, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Shahrooz Mohammadi, MBBS, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Quantitative breast density has been proposed as one of the most promising variables to stratify screening strategies; however, little is known about the relationship between density and cancer detection rates (CDR), which we evaluate in a prospectively collected cohort of patients in a UK breast screening program.

METHOD AND MATERIALS

We included 70,435 consecutive screening digital mammograms for women age 47-73 performed between March 2013 and September 2016. We excluded women at high risk as defined by National Health Service Breast Screening Programme (NHSBSP) protocols. Breast density was quantitatively measured using Volpara density software (VolparaSolutions, Edition 5 Wellington, NZ) and categorised by Volpara Density Grade (VDG). We divided our population into three 9 year age groups, 47-55, 56-64 & 65-73 in

order to compare CDR in the lowest (VDG 1) and highest (VDG 4) density women stratified by age. Differences in CDR by density group in each tertile were tested using Fisher's exact test with $p<0.05$ to signify statistical significance.

RESULTS

A total of 70,435 screening mammograms in 63,577 women were included revealing 557 cancers for an overall CDR of 0.8%. In 47-55 year olds, women in the VDG 1 density group had a CDR of 0.16%; women in the VDG 4 density group had a CDR of 0.85%. The difference of 0.69% was statistically significant ($p=0.01$). In 56-64 year olds, women in the VDG 1 density group had a CDR of 0.63%; women in the VDG 4 density group had a CDR of 0.58%. The difference of 0.04% was not statistically significant ($p=0.84$). In 65-73 year olds, women in the VDG 1 density group had a CDR of 0.99%; women in the VDG 4 density group had a CDR of 0.24%. The difference of 0.75% was statistically significant ($p=0.04$).

CONCLUSION

We found an opposite trend between breast density and CDR between the youngest and oldest age groups. Older women with the least dense breasts had a higher CDR than those with the densest breasts while the reverse was true in younger women. The differences in CDR between the densest and least dense women were statistically significant in the youngest and oldest age groups.

CLINICAL RELEVANCE/APPLICATION

The relationship between cancer detection rate and density may vary with age and should be taken into account when stratifying women into different screening strategies based on density.

SSA01-04 Is Two-Dimensional Synthetic Mammography Combined with Tomosynthesis Comparable to Conventional Full-Field Digital Mammography for the Detection of Microcalcifications at Screening?

Sunday, Nov. 26 11:15AM - 11:25AM Room: Arie Crown Theater

Participants
Yi-Chen Lai, MD, Taipei, Taiwan (*Presenter*) Nothing to Disclose
Kimberly M. Ray, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
Amie Y. Lee, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
Jessica H. Hayward, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
Rita I. Freimanis, MD, Winston-Salem, NC (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare the performance of two-dimensional synthetic mammography (SM) in combination with digital breast tomosynthesis (DBT) versus conventional full-field-digital mammography (FFDM) in the detection of microcalcifications on screening examinations.

METHOD AND MATERIALS

In this HIPAA-compliant, IRB-approved protocol, a multi-reader (n=4), retrospective observer study was conducted. Seventy-two consecutive screening mammograms performed with FFDM, digital breast tomosynthesis (DBT), and SM, which were recalled for calcifications from 2014-2015, constituted the study dataset. There were 54 benign and 18 malignant calcification cases. Twenty normal control screening mammograms without calcifications were also included. All normal or benign cases were with verified with at least 1-year follow-up and suspicious lesions verified with biopsy. Two anonymized datasets were created, one consisting of FFDM images and another consisting of SM and DBT images. Two readers reviewed each anonymized dataset. Calcification recalls were tabulated. Sensitivity and specificity for calcification detection were calculated and compared for the SM+DBT versus FFDM group. A mixed effects generalized linear model was used to account for correlation between multiple interpretations of the same image.

RESULTS

Reader agreement for FFDM was 82.6% (95%CI, 73.3%-89.7%), Cohen's kappa = 0.733, $p<0.001$ and for SM+DBT was 79.3% (95%CI, 69.6%-89.1%), Cohen's kappa = 0.677, $p<0.001$. Overall sensitivities for benign and malignant calcification detection were 77.8% and 94.4%, respectively, for FFDM versus 59.3% and 88.9%, respectively, for SM+DBT. Specificity was 100% for FFDM and 97.5% for SM+DBT. There were no statistically significant differences in either sensitivity or specificity between the study groups ($p>0.89$).

CONCLUSION

Relative to FFDM, SM in combination with DBT demonstrated a trend towards lower sensitivity for the detection of calcifications on screening examinations, although this did not reach statistical significance. There was no significant difference in specificity between the study groups. Further investigation with a larger dataset is ongoing.

CLINICAL RELEVANCE/APPLICATION

Relative to FFDM, SM in combination with DBT may have reduced sensitivity for the detection of calcifications, and therefore continued acquisition of FFDM images for screening examinations may be warranted.

SSA01-05 Cancer Detection with Digital Breast Tomosynthesis (DBT) Compared with Conventional Digital Mammography in Routine Breast Cancer Screening

Sunday, Nov. 26 11:25AM - 11:35AM Room: Arie Crown Theater

Participants
Maryam Etesami, MD, New Haven, CT (*Presenter*) Nothing to Disclose
Michelle Y. Giwerc, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

Malini Harigopal, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Digital breast tomosynthesis (DBT) is known to increase cancer detection while reducing false positive recalls in screening mammography. However, the impact of additional cancers detected is not well understood. The purpose of this study was to assess detection rate, type, size and axillary lymph node status of cancers detected with DBT compared with digital mammography (DM) alone.

METHOD AND MATERIALS

This was a retrospective institutional review board approved, HIPAA compliant study with waiver of informed consent. DM screening mammograms performed from August 1, 2008 through August 1, 2011 and DBT screening mammograms performed from August 1, 2011 through August 1, 2016 at an academic center were reviewed. DBT screening mammogram was offered to all patients after installation. Cancer detection rates were calculated and compared between the DM and DBT screening mammograms. Histological type of detected cancers, their size, receptor phenotype and lymph node status based on sentinel axillary lymph node biopsy were compared between the 2 groups of DBT and DM only screening.

RESULTS

This study included a total of 44050 screening mammograms, 28282 (64%) DBT and 15768 (36%) DM only. The cancer detection rate was 5.41 per 1000 patients screened with DBT and 4.95 per 1000 patients screened with DM only (p=0.52). There was no significant difference in proportions of in situ and invasive cancers detected (67% and 70% invasive cancers with DBT and DM only, respectively. p=0.55). However, the cancers detected with DBT were significantly smaller (1.54 ± 1.4 cm) compared with cancers detected with DM only (2.30 ± 2.3 cm) (p=0.01). Additionally, axillary lymph node metastasis in invasive cancers was reduced to approximately half with DBT screening (14.7%) compared to DM only screening (30.9%) (p=03). DBT screening detected more invasive cancers with lobular histology (13%) compared with DM only (7%), but the difference was not statistically significant (p=0.29). There was no significant difference in receptor phenotype of the cancers detected by DBT compared to DM only screening.

CONCLUSION

DBT screening detects smaller cancers with fewer positive axillary lymph nodes compared to DM. This difference may translate to less systemic treatment and improved clinical outcomes.

CLINICAL RELEVANCE/APPLICATION

DBT screening may improve breast cancer early detection compared to DM which may lead to less systemic treatment and improved clinical outcomes

SSA01-06 Association of Breast Cancer Screening Utilization and Results with Uptake of Subsequent Preventive Services

Sunday, Nov. 26 11:35AM - 11:45AM Room: Arie Crown Theater

Participants
Stella Kang, MD,MSc, New York, NY (*Abstract Co-Author*) Author, Wolters Kluwer nv
Miao Jiang, PhD, Reston, VA (*Abstract Co-Author*) Nothing to Disclose
Richard Duszak JR, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Samantha L. Heller, MD, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Danny Hughes, PhD, Reston, VA (*Abstract Co-Author*) Nothing to Disclose
Linda Moy, MD, New York, NY (*Presenter*) Nothing to Disclose

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PURPOSE

To assess for potential associations between screening mammography use and subsequent uptake of a variety of preventive services in the Medicare population, including pap smears, bone mass testing, and influenza vaccinations.

METHOD AND MATERIALS

Medicare claims from 2010-2014 Research Identifiable Files were used retrospectively to identify a group of women who underwent screening mammography and a control group without screening mammography in 2012. The screened group was divided into positive versus negative screening results, with the positive subgroup further divided into false positive and true positive findings. Bivariate and multivariate logistic regression models were used to examine the relationship between screening status and the probabilities of receiving a pap smear, bone mass measurement, or influenza vaccine in the subsequent two years. Sensitivity analysis was performed using a 2-year clean period for pap smear and bone mass testing prior to mammography for assessment of subsequent preventive service uptake.

RESULTS

The cohort consisted of 555,708 patients, 66.6% without screening mammography and 31.4% with mammography. After adjusting for patient demographics, comorbidity status, geographic covariates, and baseline preventive care, women who underwent an index screening mammogram (with either positive or negative results) were more likely than unscreened women to have a subsequent pap smear, bone mass measurement, and influenza vaccine (OR 1.52-2.75). Sensitivity analysis with a 2-year clean period for prior pap smear or bone mass testing also supported the positive association between breast cancer screening and subsequent uptake of preventive tests. Women with false positive screening mammogram results were no less likely to have a subsequent pap smear and

bone mass testing than women with negative screening results.

CONCLUSION

In female Medicare beneficiaries, screening mammography utilization is associated with higher likelihood of adherence to other preventive guidelines, and without a negative association between false positive results and near-term cervical cancer or osteoporosis screening. Potential effects of mammography on attitudes toward preventive testing merit further investigation.

CLINICAL RELEVANCE/APPLICATION

False positive mammograms do not deter women from undergoing cervical cancer or osteoporosis screening. Screening mammography use was associated with improved subsequent uptake of preventive tests.

SSA01-07 Unique Mammographically-Derived Compositional Signatures of Malignancy and Triple-Negative Breast Cancers

Sunday, Nov. 26 11:45AM - 11:55AM Room: Arie Crown Theater

Participants
Serghei Malkov, PhD, San Francisco, CA (*Presenter*) Nothing to Disclose
Roman Camarda, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
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Heather I. Greenwood, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
Jesus A. Avila, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
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John A. Shepherd, PhD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To investigate the unique lipid, water, and protein composition of malignant breast cancers by receptor status to non-malignant breast tissue in a cohort of high risk women (BIRADS 4 or greater).

METHOD AND MATERIALS

A dual-energy mammography technique (3CB) was used to quantify lipid, protein, and water composition. The lesion dataset included malignant (invasive and DCIS, N=86) and non-malignant (fibroadenoma and benign, N=282) groups. The malignant group contained 10 triple-negative and 34 receptor-positive invasive cancers. Within regions identified by the radiologists, water, lipid, and protein measures were generated and within three surrounding rings of 2 mm thicknesses. Differences and ratios between lesions and rings were also calculated. Logistic regression with cross validation was applied to analyze lesion type separation.

RESULTS

The most significant variables to discriminate malignancy were lipid differences between lesion and rings (p-value (p) =10E-5, odds ratio (OR)=0.57), protein (water) difference between lesion and rings (p=10E-4, OR=1.66), and ratios of lesion water to rings (p=10E-5, OR=1.79). At the same time, the most significant variables of triple-negative and receptor-positive discrimination were lipid difference (negative) between ring 1 and ring 3 (p=0.03, OR=0.24 (0.065, 0.86)) and the increasing lipid levels (slope) from inner to outer ring (p=0.07, OR=2.44 (0.92, 6.5)). Thus, the lipid content within the lesion relative to the surrounding rings is a marker of malignancy, but the steeper lipid gradient outside of the lesion is a marker of triple-negative breast cancer.

CONCLUSION

We found biologically meaningful water, lipid, and protein compositions of lesion and its periphery that are statistically significant for malignancy/non-malignancy and triple-negative/receptor-positive separation. In addition, future studies will determine if the lipid gradient surrounding the lesion is indicative of active lipolysis within adjacent mammary adipocytes. If true, this advanced mammography imaging technique could aid in selecting patients that benefit from inhibition of this lipolysis.

CLINICAL RELEVANCE/APPLICATION

Advanced dual-energy mammography may reduce unnecessary biopsies and better select women with invasive cancer by receptor status.

SSA01-08 Breast Cancer Detection Rate of Supplemental Screening with Abbreviated MR for Women with Dense Breasts: Preliminary Results

Sunday, Nov. 26 11:55AM - 12:05PM Room: Arie Crown Theater

Participants
Susan Weinstein, MD, Philadelphia, PA (*Presenter*) Consultant, iCAD, Inc
Mitchell D. Schnall, MD, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Elizabeth S. McDonald, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Alice Chong, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Emily F. Conant, MD, Philadelphia, PA (*Abstract Co-Author*) Consultant, Hologic, Inc Consultant, Siemens AG

PURPOSE

Dense breast tissue decreases the sensitivity of mammography and many women with dense breasts are requesting supplemental screening such as whole breast ultrasound. At our institution we offer an abbreviated Breast MRI (AB-MR) examination as an option for women seeking supplemental screening. In this study, we evaluate the early outcomes of our AB- MR examination in asymptomatic women with dense breast tissue and negative recent mammography.

METHOD AND MATERIALS

An IRB approved and HIPAA compliant retrospective review was performed of women with who underwent supplemental screening with AB-MR examination. All women were asymptomatic. Their most recent mammogram was negative or benign (BI-RADS 1 or 2) and rated as "dense" (heterogeneous or extreme). The cancer detection and false positive rates were calculated based on pathologic correlation.

RESULTS

86 women underwent supplemental screening with AB- MR from January 2016 to April 2017. The age ranged from 41 to76 years, mean 56 years. Four patients (4.6%) were categorized as BI-RADS category 4. Pathology results revealed 1 invasive ductal carcinoma,1 invasive lobular carcinoma, 1 radial scar, and 1 case of fibrocystic change. The supplemental cancer detection rate with AB- MR was 2/86 or estimated to 23 per thousand with 2 false positive exams .

CONCLUSION

Given the additional cancer detection during our early implementation of AB- MR screening, the examination appears very promising as a supplemental screening tool in women with dense breasts However, more data is needed for validation.

CLINICAL RELEVANCE/APPLICATION

Our preliminary results suggest that the AB-MR may have a role as a supplemental screening option for women with dense breast tissue.

SSA01-09 Three-Dimensional Functional Infrared Imaging in Breast Cancer Screening Of Women with Dense Breasts: Observer Performance Study

Sunday, Nov. 26 12:05PM - 12:15PM Room: Arie Crown Theater

Participants
Carl J. D'Orsi, MD, Atlanta, GA (*Presenter*) Stock options, Hologic, Inc; Consultant, Real Imaging Ltd
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Miriam Sklair-Levy, MD, Tel -Hashomer, Israel (*Abstract Co-Author*) Nothing to Disclose
Tamar Sella, MD, Jerusalem, Israel (*Abstract Co-Author*) Nothing to Disclose
Elkan F. Halpern, PhD, Boston, MA (*Abstract Co-Author*) Research Consultant, Hologic, Inc Research Consultant, Real Imaging Ltd Research Consultant, Gamma Medica, Inc Research Consultant, K2M Group Holdings, Inc
David Izhaky, PhD, Airport City, Israel (*Abstract Co-Author*) Employee, Real Imaging Ltd

PURPOSE

Three-dimensional functional infrared imaging (3DIRI) based on multiparametric evaluation of metabolic imaging biomarkers, shows promise as an indicator for the risk of a current breast cancer in women with dense breasts. Women with *positive* 3DIRI result (high risk) were recommended to undergo adjuvant contrast-ehnahced screening MRI.The objective of this study was to assess and compare, in a retrospective reader study, radiologists' performance in detection of breast cancer using 2D digital mammography alone and using 2D digital mammography with 3DIRI.

METHOD AND MATERIALS

In this retrospective, multireader, multicase, sequential-design reader study, 10 radiologists, with varying mammography experience, interpreted a cancer-enriched set of 2D mammography and 3DIRI examinations. All imaging studies were of asymptomatic women with either heterogeneously or extremely dense breasts. Observers first interpreted the 2D mammogram alone and subsequently combined with the 3DIRI cancer risk result presented as a range of -100 to +100 with numbers in the negative range indicating, in a non-ordinal manner: "no risk" for current malignancy, to +100 for "risk of current malignancy". Radiologists rated examinations using forced BI-RADS categories 1-5 and probability of malignancy on a 100 point scale with 0 as "no possibility of malignancy present" and 100 as "malignancy present". The analysis included 40 cases: 30 noncancers and 10 histology confirmed cancer cases. Reader performance was compared using the receiver operating characteristics (ROC) curve and the area under the curve (AUC) for mammography alone and for mammography with 3DIRI.

RESULTS

Multi-reader pooled ROC analysis yielded AUC of 0.71 for mammography alone and 0.87 for mammography with 3DIRI, yielding a statistically significant 22% relative increase in AUC (change in AUC of 0.16 [95% confidence interval: 0.04-0.27]; $p < 0.05$).

CONCLUSION

Adding 3DIRI to mammography significantly improved reader's detection of breast cancer in women with dense breast tissue.

CLINICAL RELEVANCE/APPLICATION

3D functional infrared imaging, a non-contract, non-radiation imaging modality, can correctly classify women for their current risk of breast cancer with high efficacy Assessing the likelihood for breast cancer non-invasively can assist in risk-stratified screening programs

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103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
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SSA02

Science Session with Keynote: Breast Imaging (Contrast Enhanced Mammography)

Sunday, Nov. 26 10:45AM - 12:15PM Room: N227B

BR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Christiane K. Kuhl, MD, Bonn, Germany (*Moderator*) Nothing to Disclose
John M. Lewin, MD, Denver, CO (*Moderator*) Consultant, Hologic, Inc; Consultant, Novian Health Inc

Sub-Events

SSA02-01 Breast Keynote Speaker: Contrast Enhanced Mammography

Sunday, Nov. 26 10:45AM - 10:55AM Room: N227B

Participants
Martin J. Yaffe, PhD, Toronto, ON (*Presenter*) Research collaboration, General Electric Company; Founder, VOLPARA Technologies; Shareholder, VOLPARA Technologies; Co-founder, Mammographic Physics Inc

SSA02-02 Contrast-enhanced Digital Mammography Plus Mammography, Magnetic Resonance Imaging Plus Mammography and Mammography Alone: A Comparison of Diagnostic Performance in Symptomatic Women

Sunday, Nov. 26 10:55AM - 11:05AM Room: N227B

Participants
Wei Tang, Shanghai, China (*Presenter*) Nothing to Disclose

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PURPOSE

To compare the diagnostic efficiency of contrast-enhanced digital mammography (CEDM) plus digital mammography (DM) and magnetic resonance imaging (MRI) plus DM in symptomatic women.

METHOD AND MATERIALS

Between June and December 2015, 196 patients with 240 histologically proven lesions all underwent DM, CEDM and MRI. Two radiologists were responsible for interpreting all images according to the Breast Imaging Reporting and Data System (BI-RADS). The diagnostic performance of each method was assessed by receiver-operating characteristic (ROC) curve. The sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) were compared using McNemar's test and Fisher's exact test. A Kappa test was used to assess the interobserver agreement.

CONCLUSION

The diagnostic performance of CEDM and MRI combined with DM is superior to that of DM alone in symptomatic women; MRI plus DM is slightly better than that of CEDM plus DM, but this difference was not statistically significant

CLINICAL RELEVANCE/APPLICATION

Besides MRI, CEDM is a good tool for breast cancer diagnosing.

SSA02-03 Use of Contrast Enhanced Digital Mammography for Women with Palpable Breast Abnormalities

Sunday, Nov. 26 11:05AM - 11:15AM Room: N227B

Participants
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PURPOSE

To determine whether CEDM may replace the standard practice of mammography plus targeted ultrasound in the work-up of

To determine whether CEDM may replace the standard practice of mammography plus targeted ultrasound in the work-up of patients with palpable breast abnormalities.

METHOD AND MATERIALS

Patients presenting for evaluation of a palpable mass were consented for this prospective HIPAA-compliant and IRB-approved study between April 2015 and April 2017. 183 women with 200 palpable lesions were evaluable. The region of the palpable abnormality was marked. CEDM was performed with standard MLO and CC views plus a spot film over the palpable abnormality. Low energy images were interpreted first after which contrast enhanced images were provided. Targeted ultrasound was performed. Suspicious lesions were biopsied with appropriate imaging guidance. Any suspicious finding seen only on CEDM was evaluated by MRI for possible biopsy. If not seen on MRI, a 6-month follow up CEDM was performed. Detection rates and PPV3 for CEDM and ultrasound were calculated. Pathology and/or one-year follow up were the gold standard. Patient characteristics including age, menstrual status, breast density, breast parenchymal enhancement and risk factors were recorded.

RESULTS

Mean patient age was 52 (30-80 years). Eighty-three palpable lesions had no imaging correlate and 100 were cysts, fat necrosis or biopsied yielding other benign abnormalities. Seventeen malignant lesions were detected: 14/17 (82%) by CEDM and 16/17 (94%) by ultrasound. Ultrasound and CEDM missed the same cancer which was detected by MRI. PPV3 of CEDM was 42% and ultrasound 37% ($p<.0001$).

CONCLUSION

The cancer detection rate of CEDM in this population suggests that CEDM cannot be used to replace mammography plus targeted ultrasound in the work up of palpable abnormalities, although confirmation in a larger study is required for a definitive conclusion.

CLINICAL RELEVANCE/APPLICATION

A negative CEDM did not reliably exclude breast cancer. Mammography plus targeted ultrasound should remain the standard work-up of women with palpable abnormalities.

SSA02-04 Utility of Contrast Enhanced Digital Mammography for Breast Cancer Screening

Sunday, Nov. 26 11:15AM - 11:25AM Room: N227B

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PURPOSE

To evaluate basic performance metrics of contrast enhanced digital mammography (CEDM) when used for breast cancer screening.

METHOD AND MATERIALS

IRB approved retrospective review was performed to identify CEDMs performed for routine breast cancer screening between December 2012- April 2016. Medical records were reviewed for risk factors (family history, personal history, BRCA status, prior high risk lesion). The number of biopsies recommended and cancers detected were recorded as well as the tumor histopathologies.

RESULTS

A total of 1197 screening CEDMs were performed during the study period. Median age was 52 (range: 25-82). 319 (27%) women had a family history of breast cancer in a 1st degree relative <50, 470 (39%) a personal history of breast cancer, 103 (9%) a known BRCA mutation, and 371 (31%) a history of a high risk lesion. 1073 (89%) studies were given a BI-RADS 1 or 2 assessment, 28 (2%) a BI-RADS 3, and biopsy recommended in 71(6%). MRI was recommended for further evaluation of a contrast only finding in 31 (3%) women. 22 cancers were detected (12 invasive ductal cancers, 2 invasive lobular cancers, 1 invasive mammary cancer, 7 cases of DCIS) for a PPV3 of 31% and a cancer detection rate of 18/1000.

CONCLUSION

CEDM is a promising technology that may be used for breast cancer screening of intermediate risk women. The BI-RADS 3 rate, PPV3, and relative proportion of DCIS to invasive cancers are comparable to screening mammography.

CLINICAL RELEVANCE/APPLICATION

CEDM may be a potential alternative screening technique for women at intermediate risk for breast cancer.

SSA02-05 Adding the Merits of Contrast to the Ease of Mammography: Can We Highlight What's Behind Breast Asymmetries?

Sunday, Nov. 26 11:25AM - 11:35AM Room: N227B

Participants
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PURPOSE

TThe purpose of this study is to assess the impact of including contrast mammography in the characterization of mammography identified breast asymmetries.

METHOD AND MATERIALS

This prospective study included 380 patients with mammography identified breast asymmetries: single view, focal, global and developing asymmetries. Contrast enhanced spectral mammography (CESM) was performed using the same machine. A pair of low and high energy images wastaken in each position. Lesions were classified into enhancing and non-enhancing lesions. Enhancing lesions (focus, mass and non-mass) were further categorized according to the ACR MRI BIRADS lexicon. Core and surgical biopsy was taken and histopathology results were correlated with the corresponding imaging findings and accordingly the diagnostic indices of mammography alone and when adding CESM were calculated and compared.

RESULTS

The study included 380 mammography identified breast asymmetries: 230/380 (60.5%), focal, 128/380 (33.7%) global 20/380, (5.3%) single view and 2/380 (0.5%) developing asymmetries. Additional mammography signs (microcalcifications, distortion and skin thickening) were identified in 56/380 cases and they strongly correlated with an underlying malignant pathology ($p<0.05$). After contrast injection, no contrast uptake was seen in 88 cases (74 benign and 14 malignant lesions). Enhancing lesions were classified as focus (16/380,), mass (121/380) and non-mass(155/380). The calculated sensitivity, specificity positive and negative predictive values of mammography were 82.8%, 46.8%, 66.8% and 75.7% as compared to 94.4%, 76.4%, 88.5% and 87.4% after adding CESM. False negative lesions on CESM were 14/380 non enhancing malignant lesions (mainly DCIS) while false positive cases were 30/380 inflammatory breast lesions and atypical fibroadenomas showing malignant morphology descriptors.

CONCLUSION

CESM should be incorporated in the diagnostic workup of breast asymmetries to highlight or exclude underlying malignant lesions with the exception of when an underlying inflammatory process is considered due to the high incidence of false positive results in this case.

CLINICAL RELEVANCE/APPLICATION

Mammography identified breast asymmetries pose a diagnostic challenge and they often entail un necessary diagnostic and interventional procedures. CESM when added to Mammography can help in the characterization of the underlying pathology.

SSA02-06 Automatic Classification of Breast Lesions in Contrast Enhanced Spectral Mammography Using Deep Learning

Sunday, Nov. 26 11:35AM - 11:45AM Room: N227B

Participants
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Arnaldo Mayer, PhD, Ramat Gan, Israel (*Abstract Co-Author*) Co-founder, RadLogics Inc; Officer, RadLogics Inc

PURPOSE

This work presents a method for automatic breast lesion classification in dual energy contrast enhanced spectral mammography (CESM). The aim is to assess its feasibility and to evaluate the potential for biopsy sparing in benign breast lesions.

METHOD AND MATERIALS

A dataset of 130 CESM breast lesions was generated retrospectively from 65 benign and 65 malignant lesions following biopsy. Each lesion was manually contoured using standard PACS viewer drawing tools. Based on this data set, a supervised learning algorithm was developed to tell apart benign from malignant lesions. A supervised classifier was constructed using deep learning methods (DL) in conjunction with transfer learning. The transfer learning approach begins with a pre-trained neural network (AlexNet), trained on the ImageNet database, comprised of 14 million natural images from 1000 different classes. This network was further fine-tuned for our CESM data set, in order to extract strong features representing the characteristic patterns of benign and malignant lesions. A subset of 82 lesions was used to train the network (back-propagation) while 13 other provided inter-epoch validation. Eventually, the trained network was tested on the remaining set of 35 lesions (which were not used for training). A classification score was generated by the network for each lesion in the test set (see the Figure; benign -blue and malignant-red). A higher score signifies a higher probability for that lesion to be malignant. Malignant/benign classification is performed by imposing a selected threshold value on the classification score. The value of this threshold determines the sensitivity and specificity of the corresponding working point.

RESULTS

Setting a conservative score threshold of 0.2 (Figure), leads to Sensitivity = 0.95 and Specificity = 0.47, corresponding to a potential 47% sparing in biopsies at the cost of 1 false negative.

CONCLUSION

This work demonstrates the feasibility of automatic lesion classification in dual energy CESM images. The method has the potential to reduce the number of benign breast biopsies while preserving high sensitivity.

CLINICAL RELEVANCE/APPLICATION

Automatic, or computer assisted lesion classification in CESM images has the potential to reduce the number of benign breast biopsies, thereby reducing both the patient anxiety and the medical costs.

SSA02-07 Contrast-enhanced Cone-beam Breast-CT (CBCT) vs Non-contrast CBCT, Mammography and MRI: Diagnostic Accuracy for Breast Cancer Detection in Dense Breast Tissue

Sunday, Nov. 26 11:45AM - 11:55AM Room: N227B

Participants
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PURPOSE

To evaluate the diagnostic accuracy of contrast-enhanced cone-beam breast-CT (CE-CBCT) in dense breast tissue and compare it to non-contrast CBCT, mammography (MG) and magnet resonance imaging (MRI).

METHOD AND MATERIALS

In this prospective ethics-board approved study, 41 women (52 breasts, 100 lesions), median age of 57.9 years (IQR 48.9-64.9, range 41.6-78.6 years) with ACR density type c or d and BI-RADS 4 or 5 assessment in MG and/ or ultrasound were included. Based on amended ACR BI-RADS criteria, MG, non-contrast CBCT, CE-CBCT and MRI were independently evaluated by two blinded readers. The area under the receiver operating curve (AUC), sensitivity and specificity were compared between the different imaging modalities. All data were evaluated by means of descriptive statistics. ANOVA-type statistics were used for comparison.

RESULTS

Histological examination was performed on 63 breast lesions (6 benign, 6 high-risk, 51 malignant). Follow-up imaging was performed for 37 lesions. The AUCs for breast cancer diagnosis for reader 1 and 2 were: 0.79/ 0.69 (CE-CBCT), 0.78/ 0.76 (MRI), 0.70/ 0.62 (non-contrast CBCT) and both 0.69 (MG). CE-CBCT improved breast cancer diagnosis sensitivity by 30-37% in comparison to MG, and was comparable to MRI (MG: 0.84/ 0.93 vs. MRI: 0.70/ 0.86). Associated ANOVA-type statistics for differences in AUC and sensitivity across imaging modalities were $p=0.0443$ and $p<0.001$, respectively.

CONCLUSION

This study showed that CE-CBCT can accurately identify malignant breast lesions in a diagnostic setting. CE-CBCT improved lesion detection in comparison to MG and non-contrast CBCT and was comparable to MRI in density type c and d breasts.

CLINICAL RELEVANCE/APPLICATION

The results show that CE-CBCT is a promising new method that may be a suitable alternative to MRI in patients with contraindications to MRI or in regions with limited MRI availability.

SSA02-08 The Impact of Automated Breast Ultrasound versus Contrast Enhanced Spectral Mammography on the Local Staging of Breast Cancer

Sunday, Nov. 26 11:55AM - 12:05PM Room: N227B

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PURPOSE

to compare contrast enhanced spectral mammography and automated breast ultrasound with regards to cancer size, extension and multiplicity in reported cases with breast cancer

METHOD AND MATERIALS

Institutional review board approval and patient informed consent were obtained from 70 patients with proved breast cancer (64% invasive ductal grade II, 16% invasive ductal grade III and 20% invasive lobular). 3D ABUS were done for anteroposterior ;lateral and medial acquisitions and CESM performed using low and high energy exposures in craniocaudal and mediolateral oblique views after IV injection of contrast agent. Included breast cancers were analyzed regarding disease extension, size, and multiplicity.Operative data was the gold standard reference

RESULTS

CESM and 3D ABUS showed comparable measurements of the cancer size and their accuracy was 95% and 93% respectively. ABUS

CESM and 3D ABUS showed comparable measurements of the cancer size and their accuracy was 95% and 93% respectively. ABUS was superior in evaluating cancer extension to the surroundings (parenchyma +/- skin) with an accuracy of 90% compared to 87% for CESM. Multiplicity was better demonstrated by CESM that showed an accuracy of 96% compared to 90% by ABUS. The overall performance of CESM in staging of breast cancer was 95.7% sensitivity, 88% specificity and 93% total accuracy versus 95%, 76.5% and 91.3% respectively for ABUS.

CONCLUSION

3D ABUS is a non-invasive alternative tool to CESM in the staging of breast cancer. ABUS was non-inferior to CESM in the evaluation of cancer size. 3D ABUS is more accurate in determining parenchymal infiltration and CESM is better in detection of multiplicity.

CLINICAL RELEVANCE/APPLICATION

ABUS is considered a revolution in breast scanning by ultrasound imaging that can be used as a non-invasive, fast and easy tool of breast imaging in early detection (in other words; screening) and staging of breast carcinomas

SSA02-09 Comparison of MRI, CEM and MBI for Staging Breast Cancer in Women with a Newly Diagnosed Breast Cancer

Sunday, Nov. 26 12:05PM - 12:15PM Room: N227B

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PURPOSE

To compare MRI, MBI and CEM imaging assessments of index lesions and extent of disease with pathology in patients with newly diagnosed breast cancer.

METHOD AND MATERIALS

We compared results from 79 women with biopsy-proven breast cancers in 80 breasts who underwent, under an IRB-approved protocol, MRI, MBI and CEM within one week. Six specifically trained, breast radiologists participated in the study. Each examination was independently interpreted prospectively by one radiologist with full access to all prior breast imaging, but blinded to the interpretations of the two other study modalities. Findings for the 80 cancers were recorded and compared in a side by side review/correlation with surgical pathology (59 cases) and in neo-adjuvant treated cases (21) with image-guided biopsy results.

RESULTS

The primary cancers consisted of 40 IDC, 17 IDC/DCIS, 18 ILC, and 4 DCIS and 1 IDC/ILC only. Segmental mastectomy or mastectomy was performed on 57 women, (58 breasts) without neo-adjuvant therapy and 51 of these were detected by all three modalities. The average size by pathology of the primary index cancers was 31 mm and were measured by the radiologists on imaging as 33 mm, 29 mm and 32 mm for MRI, CEM and MBI, respectively ($p=0.17$). The range in imaging sizes for primary index cancers was 3-95 mm by pathology. Four verified index lesions were missed on CEM, four on MBI and three on MRI. 7 cases were correctly upstaged from an original diagnosis of unifocal to multi-focal (3 MRI, 2 CEM, and 3 MBI) and multi-centric (2 MRI, 2 CEM, and 1 MBI). MRI depicted 42 false positive enhancing regions, CESM 16, and MBI 16 ($p<0.01$). A radiologist rendered a report considering all imaging studies that led in 6 cases to changes in surgical management based on the additional information provided. Of these, 2 were affected by all three modalities, while 1 primarily by MRI, 3 primarily by CEM, and none primarily by MBI.

CONCLUSION

All three modalities performed comparably in terms of sensitivity and in estimating tumor size, as compared with surgical pathology. MRI was slightly more sensitive than CEM and MBI, but had significantly more false positives than CEM and MBI.

CLINICAL RELEVANCE/APPLICATION

Breast MRI is extremely sensitive for cancer staging, but has more false positive findings. Access and expense issues remain. MBI and CEM are possible alternatives to MRI for this purpose.

SSA03

Cardiac (Anatomy and Function)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S502AB

CA CT MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Carole J. Dennie, MD, Ottawa, ON (*Moderator*) Speaker, Bayer AG; Spouse, Consultant, Abbott Laboratories

Sub-Events

SSA03-01 Sparse CINE SSFPs for Assessment of Left Ventricular Mass in Cardiac MRI: Accuracy in Patients with Structural Myocardial Inhomogeneities

Sunday, Nov. 26 10:45AM - 10:55AM Room: S502AB

Participants
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PURPOSE

To investigate in a sparse 2D real-time CINE TrueFISP sequence featuring iterative reconstruction (SSIR) possible influence of structural myocardial inhomogeneity indicated by presence of late-gadolinium enhancement (LGE+) with regard to accuracy of left ventricular (LV) mass assessment.

METHOD AND MATERIALS

In patients undergoing cardiac MRI on a 3 Tesla system the SSIR sequence was acquired - once in a single-breath-hold (sBH) and once during free breathing (non-BH) -, as well as the fully-sampled multi-breath-hold reference standard sequence (RS) for LV analysis. LV mass assessment was performed with dedicated software (Argus, Siemens Healthcare Sector). Agreement of SSIR and RS for mean LV mass (LVMavg) and end-diastolic LV mass (LVEDM) was determined with Bland-Altman-analysis and linear regression analysis.

RESULTS

51 patients (25 LGE+; 26 LGE-) who underwent LGE-imaging and LV analysis with the RS and the SSIR sequence were investigated. Linear regression analysis revealed with sBH-SSIR in comparison to RS excellent correlation coefficients r from 0.95-0.96 in LGE+ patients, from 0.96-0.99 in LGE- patients and with non-BH-SSIR r from 0.97-0.98 in LGE+ and 0.95-0.98 in LGE- patients, respectively. Significant overestimation was found in Bland-Altman-analysis in sBH-SSIR and non-BH-SSIR LV mass assessment in both LGE+ and LGE- patients when compared to RS results (all p-values < 0.05).

CONCLUSION

Albeit high correlation of SSIR and RS results regarding LV mass assessment, significant LV mass overestimation was found using SSIR datasets for LV analysis- both when acquired with a single breath-hold or during free breathing. Results don't differ between LGE+ and LGE- patients.

CLINICAL RELEVANCE/APPLICATION

Albeit high correlation of SSIR and RS measurements, LV mass is systematically overestimated when using sparse sampling featuring iterative reconstruction (SSIR) imaging for the analysis.

SSA03-02 Left Ventricular and Left Atrial Volumetric Function: Impact of Inspiratory Breath Holding

Sunday, Nov. 26 10:55AM - 11:05AM Room: S502AB

Participants
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PURPOSE

To compare left ventricular and left atrial volumetric function employing the same cine imaging technique during inspiratory breath-hold and during free breathing.

METHOD AND MATERIALS

49 subjects without symptoms of cardiopulmonary diseases underwent steady-state free precession cine real-time imaging during inspiratory breath-hold and free breathing at 3T. The left ventricle (LV) and the left atrium (LA) were covered in 4-chamber orientation. LV (end-diastolic volume, EDV; end-systolic volume, ESV) and LA (maximum, LAVmax; minimum, LAVmin; before contraction, LAVbc) volumes were derived by semi-automatic segmentation. LV stroke volume (SV) and ejection fractions (LV ejection fraction, EF; total/passive/contractile LA ejection fraction; LATEF/LAPEF/LACEF) were calculated. LV peak ejection rate (PER) as well as LV early (PFRE) and late (PFRA) diastolic peak filling rates were derived from LV volume-time curve. Corresponding breathing and breath-hold parameters were compared by paired t-test and correlation analysis.

RESULTS

All LV and LA volumes decreased during inspiratory breath-hold, EDV, ESV and LAVmax significantly (EDV, 136±28 ml vs. 131±31 ml, p=0.04; ESV, 62±17 ml vs. 59±17 ml, p=0.01; SV, 74±15 ml vs. 67±17 ml, p=0.21; LAVmax, 86±18 ml vs. 80±18 ml, p<0.01; LAVmin, 46±13 ml vs. 46±13 ml, p=0.57; LAVbc, 63±16 ml vs. 62±16 ml, p=0.35). PER was not altered during breath-hold (-410±83 ml/s vs. -416±95 ml/s; p=0.38), diastolic filling rates significantly decreased (PFRE, 334±88 ml/s vs. 299±97 ml/s; p<0.01; PFRA: 283±81 ml/s vs. 259±82 ml/s; p<0.01). LATEF (47±6% vs. 43±8%, p<0.01) and LAPEF (27±5% vs. 22±6%, p<0.01) significantly decreased during inspiratory breath-hold whereas EF (55±6% vs. 55±6%, p=0.22) and LACEF (27±6% vs. 27±7%, p=0.52) did not reveal significant differences. Correlations between breathing and breath-hold parameters ranged from r=0.66 for LACEF to r=0.87 for LAVmin and EF.

CONCLUSION

Inspiratory breath-holding significantly alters left ventricular and left atrial volumetric function. Moreover, derived correlation coefficients indicate substantial variations in the individual effect of inspiratory breath-holding between subjects.

CLINICAL RELEVANCE/APPLICATION

Breathing state should be taken into account in the assessment of left ventricular and atrial function, especially for follow-up of patients and comparison of parameters with echocardiography.

SSA03-03 Left Atrial Appendage Closure Guided By 3D Printed Patient-Specific Models

Sunday, Nov. 26 11:05AM - 11:15AM Room: S502AB

Participants
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PURPOSE

Percutaneous left atrial appendage (LAA) occlusion has emerged as an alternative therapeutic approach to medical therapy for stroke prevention in patients affected by atrial fibrillation. Our aim was to assess whether the sizing of the implanted occluder device, based on the sole medical image analysis, is in accordance with the sizing obtained using the 3D printing models recostructed by computed Tomography Angiography (CTA).

METHOD AND MATERIALS

We used 3D printing to create patient-specific LAA models. We retrospectively identified 13 cases of LAA occlusion. For each case, we segmented the pre-operative CTA scan by ITK-snap creating a LAA 3D model (Caretronik, Prato, Italy), that was considered suitable for 3D stereolithography printing (SLA) technique (Form 2 Desktop, Formlabs Inc., MA, USA). Two independent observers measured the LAA landing zone, major and minor axis. The measurements were used for sizing. A rehearse occlusion was then accomplished using the 3D printed LAA and the occluder device models; the resulting values were subsequently compared with the size of the implanted device to assess agreement, over or underestimation and its correlation with post-operative drawbacks.

RESULTS

Thirteen patients, undergoing percutaneous LAA occlusion, were retrospectively analyzed; for each of them a patient-specific 3D LAA printed model was manufactured using pre-operative CTA images. The comparison between the 3D printed model sizing and the actual sizing revealed that: i) in 54% of the cases (n=7) the actual sizing was underestimated when compared to the 3D printed model; ii)in 38% of the cases (n=5) the two sizing approaches matched; iii) only in 1 case (8%) an overestimation of the actual size compared to the 3D printed model was detected. It is worth noticing that in all underestimated cases a drawback, such as leakage or device migration was observed; consequently, the results suggest that the use of 3D printing models help in finding the correct size of the device, potentially avoiding the negative outcome of the surgery.

CONCLUSION

3D printing LAA model may contribute in sizing the device, finding its correct position and guiding the choice of the device, providing additional data to angiography and TEE.

CLINICAL RELEVANCE/APPLICATION

3D printing left atrium appendage model may contribute in sizing the device, finding its correct position and guiding the choice of the device.

SSA03-04 Deformable Registration Based Analysis of Cine MR for Quantification of Regional Myocardial Function: Validation with Myocardial Tagging

Sunday, Nov. 26 11:15AM - 11:25AM Room: S502AB

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PURPOSE

The aim of this study is to validate deformable registration algorithms using cine SSFP data for analysis of myocardial strain in comparison to myocardial tagging.

METHOD AND MATERIALS

17 patients referred for cardiac MRI and 17 healthy volunteers were prospectively enrolled. LV peak systolic global longitudinal strain (GLS) and peak systolic global circumferential strain (GCS) were measured on respective long and short axis SSFP cines using a prototype automatic contouring tool (Langrangian strain) with integrated inverse deformable registration analysis (DRA) (TrufiStrain, Siemens Medical Solutions, Princeton, US). In identical slice orientation tagging was performed with subsequent HARP analysis for reference-standard comparison (Eulerian strain). For assessment of intra-observer variation, a repeat analysis of data was performed after >=4 weeks. Statistical testing included paired t-test, linear regression analysis, Pearson's correlation and coefficient of variance (CV) analysis.

RESULTS

Evaluated strain data using DRA and HARP demonstrated significant relationships to left ventricular ejection fraction (all P<0.0001). DRA demonstrated strong correlations with HARP for myocardial GLS (r=0.87;P<0.0001) and GCS (r=0.78; P<0.0001). Similar results were found for endocardial GLS (r=0.78; P<0.0001) and GCS (r=0.72; P<0.0001). For endocardial GCS (-18.7%;IQR:-22.2/-16.8% vs. -15.7%; IQR:-18.8/-13.8%;P< 0.0001) and myocardial GLS (-13.7;IQR:-16.6/-11.4% vs. -12.2; IQR:-14.6/-9.5%;P<0.0001) DRA measures were significantly lower than HARP with no differences for myocardial GCS and endocardial GLS (P=NS). DRA demonstrated substantially lower intra-observer variation than HARP for endocardial GLS (CV 3.3/6.6%) and GCS (CV 3.8/7.7%) as well as myocardial GLS (CV 1.6/7.6%) and GCS (CV 2.4/9.3%).

CONCLUSION

Deformable registration based analysis of cine SSFP data provides an accurate and highly reproducible alternative to myocardial tagging for myocardial strain assessment without the need for additional image acquisition (i.e. tagged images). Identifiable differences in absolute values likely relate to differences in the applied reference frame of methods (Lagrangian vs. Eulerian strain).

CLINICAL RELEVANCE/APPLICATION

Automated, accurate and reproducible measurement of strain using standard cine SSFP data can promote routine use of this technique in clinical practice for identification of subclinical myocardial dysfunction.

SSA03-05 The Application of Optimized TPAT Technique in Arrhythmia Patients

Sunday, Nov. 26 11:25AM - 11:35AM Room: S502AB

Participants
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PURPOSE

Traditional CMR cine sequence is an useful tool for assessing the movement of heart. However, the poor image quality and motion artifacts caused by arrhythmia may hamper the diagnostic quality of CMR images. Now, the optimized temporal parallel acquisition technique (TPAT) can allowing free-breathing of subjects and meanwhile provides a similar diagnostic values for radiologists, which may improve this situation.

METHOD AND MATERIALS

Experiment: Twenty-five patients with arrhythmia and thirty-three patients with normal heart rhythm were included in this study. CMR scan was performed using a 3.0T system. Cine images were acquired by bSSFP sequence with conventional retrospective ECG-triggering method and the optimized real-time TPAT technique in the same planes. Image analysis: For quantitative analysis, LV segmental myocardial longitudinal strain(LS), LV circumferential strain and radial strain(CS and RS) were measured by dedicated software (CVI42 version 5.3.0), LV volumes and function were measured using Argus software (Siemens Healthcare, Erlangen, Germany). LV volumes and function were measured in the short axis level. Apparent contrast-to-noise ratio (CNR) between LV myocardium and blood pool was calculated. Besides, LV segmental myocardial thickness were also measured.

RESULTS

In the normal rythm group, there were no differences in evaluation of LV volumes, function and segmental myocardial thickness between the conventional method and TPAT technique. while there are obvious difference ($p<0.05$) on EF,LVSV,LVESV,LVCO and Mass in patients with arrythmia. (table 1,2). In addition,there were no obvious difference on radial strain, circumferencial strain and longitudial strain in the normal group. However, in patients with arrythmia, the values of basal anterior,basal anteroseptal,mid anterolateral,apical anterior and apical lateral of radial strain, basal anterior,basal anteroseptal,mid Inferolateral,mid anterolateral and apical lateral of circumferencial strain and mid anterolateral longitudinal strain were significantly different.(table 3.) The IQ of TPAT technique was higher than that of conventional method in patients with arrhythmia on the whole. (Figure 1).

CONCLUSION

In conclusion, optimized TPAT technique can provide better IQ in most patients with arrhythmia, and it also has the advantages of allowing free-breathing scans.

CLINICAL RELEVANCE/APPLICATION

For patients with arrythmia, it will make the exam better.

SSA03-06 Compressed Sensing Real-Time Cine Imaging in Patients with Cardiac Arrhythmia: Does It Help to Reduce Mis-Triggering Artifacts?

Sunday, Nov. 26 11:35AM - 11:45AM Room: S502AB

Participants
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PURPOSE

To evaluate the impact of a Compressed Sensing (CS) real-time prototype cine sequence (Sparse 2D cine, Siemens Healthineers) on mis-triggering artefacts and image quality in patients with arrhythmia, in comparison with the reference cine-imaging technique.

METHOD AND MATERIALS

71 consecutive adult patients (41 males; mean age = 59 ± 20.6 years), referred for cardiac magnetic resonance (CMR) examination with concomitant irregular heart rate (defined by R-R interval variation > 10%) during scanning, were prospectively enrolled. For each patient, two series of cine images were systematically acquired: (a) a standard segmented multi-breath-hold steady-state free precession (bSSFP) sequence including short-axis stack, one four-chamber slice, one two-chamber slice (Group 1) and (b) an additional real-time CS single-breath-hold prototype sequence (Group 2) providing the same slice number, position and thickness as the reference technique. Two radiologists independently assessed mis-triggering artefacts, objective and subjective image quality for both acquisition techniques.

RESULTS

The mean heart rate variation was 38% ± 22.8 (range: 11 - 122). A total of 609 cine slices were evaluated in each Group (mean number of slices per patient = 8.6 ± 1.9). The average number of slices with mis-triggering artefacts per patient was higher in Group 1 than in Group 2 (4.5 ± 2.9 vs 0.1 ± 0.5, $p<0.0001$). The European CMR registry standardized artefact score was lower in Group 2 than in Group 1 (1.0 ± 1.2 vs 2.37 ± 1.2 respectively, $p<0,0001$). Subjective image quality score was improved in Group 2 compared to Group 1 (3.3 ± 0.9 vs 2.7 ± 1.0 respectively, $p=0.0002$).

CONCLUSION

Compressed Sensing real-time cine imaging drastically reduces mis-triggering artefacts and improves image quality of CMR cine acquisition in patients with arrhythmia.

CLINICAL RELEVANCE/APPLICATION

In addition to reduce CMR scan time, CS real-time cine imaging improves the interpretability of CMR cine images in patients with arrhythmia with almost no mis-triggering artefacts.

SSA03-07 Comparison of Cardiac and Late-Enhancement Dual-Energy CT with Electro-Anatomical Maps in Patients with Implanted Cardioverter-Defibrillator before Ventricular Radiofrequency Ablation

Sunday, Nov. 26 11:45AM - 11:55AM Room: S502AB

Participants
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PURPOSE

To compare characteristics of myocardial scar as assessed with cardiac and late-enhancement dual-energy CT (DECT) during pre-interventional imaging with the findings obtained with electro-anatomical mapping (EAM) acquired during radio frequency cardiac ablation (RFCA).

METHOD AND MATERIALS

A total of 12 patients referred for catheter ablation of ventricular tachycardia (VT), who were not eligible for MRI due to incompatible implantable cardioverter-defibrillators (ICD's), were assessed for left ventricular wall thinning (WT) and wall motion abnormalities (WMA) on a cardiac scan as well as for scarring on late-enhancement images acquired using a DECT (Siemens Somatom Flash, Forchheim, Germany). Voltage maps were acquired during RFCA to identify myocardial segments with scar (Bipolar <1.5mV, unipolar <8mV). Using the 17-Segment AHA Model, segmental comparison between areas of WT, WMA and scar on CT and EAM was performed. Descriptive statistics and Cohen's kappa test were applied.

RESULTS

Wall thinning was observed in 10 out of 12 patients, wall motion abnormalities in all 12 patients and scars in 11 out of 12 patients on CT scans. Also, left ventricular wall involvement and mural distribution were noted. Overall segmental concordance between CT and EAM was observed in an average of 11 out of 17 segments ($\kappa = 0.55$), no concordance was seen for an average of 2 segments. An average of 4 segments was not evaluable due to missing data points on EAM. CT identified segments characterized by low voltages with high sensitivity (84.6%), reasonable specificity (75.9%) and reasonable negative predictive value (75.8%).

CONCLUSION

Cardiac CT with late-enhancement dual-energy phase is a valuable method to assess patients with a non-MRI compatible ICD prior to scar ablation. It can provide a 3-dimensional characterization of VT scar substrate, areas of wall thinning and of abnormal wall motion in addition to an anatomic model of the heart.

CLINICAL RELEVANCE/APPLICATION

Pre-interventional cardiac and late-enhancement dual-energy CT offers assistance to plan EAM and RFCA procedures in patients not eligible for MRI.

SSA03-08 Evaluation of Left Atrial Appendage Emptying after Successful Radiofrequency Catheter Ablation of Atrial Fibrillation: Cardiac Magnetic Resonance Imaging Study

Sunday, Nov. 26 11:55AM - 12:05PM Room: S502AB

Participants
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PURPOSE

To evaluate the flux and timing of left atrial appendage (LAA) emptying using velocity encoding cardiac magnetic resonance imaging (VENC-MRI) in patients who underwent successful catheter ablation of atrial fibrillation (AF).

METHOD AND MATERIALS

42 patients (mean age: 57.6 ± 10.7 years, male: 33) underwent VENC-MRI for quantification of LAA emptying after successful catheter ablation of AF. From VENC-MRI data during sinus rhythm, the maximum blood flow from LAA to left atrium was defined as the LAA emptying. Depending on the timing of LAA emptying, all patients were divided into two groups: 1) left ventricular systolic phase (LVSP) emptying and 2) left ventricular diastolic phase (LVDP) emptying. Additionally, the flux (in ml/s) of LAA emptying was measured.

RESULTS

Of all 42 patients, 11 (26.1%) performed the electrical isolation of pulmonary vines as well as LAA. In basis of VENC-CMR results, 34 (81%) and 8 (19%) were assigned into 1) LVSP emptying and 2) LVDP emptying, respectively. Mean flux of LAA emptying was significantly greater in the LVDP emptying than in the LVSP emptying (74.9 ± 22.4 ml/s vs. 38.0 ± 20.4 ml/s, $p < 0.001$). Using the presence of LVSP emptying to predict the prior electrical isolation of LAA gave 72.7% sensitivity, 100% specificity, and 100% positive and 91.1% negative predictive values.

CONCLUSION

The VENC-MRI can allow the comprehensive evaluation of LAA emptying related to the electrical isolation of LAA in patients who terminated AF with catheter ablation.

CLINICAL RELEVANCE/APPLICATION

Velocity encoding cardiac magnetic resoance imaging can help assess noninvasively the pattern of left atrial appendage emptying in normal sinus after successful catheter ablation of atrial fibrillation.

SSA03-09 Deep Learning for Cardiac MRI: Automatically Segmenting Left Atrium Expert Human Level Performance

Sunday, Nov. 26 12:05PM - 12:15PM Room: S502AB

Participants
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PURPOSE

To develop a deep learning based fully automatic segmentation engine for left atrium (LA) and proximal pulmonary veins (PPVs) from cardiac MR images

METHOD AND MATERIALS

We acquired a publicly available, anonymized cardiac MRI data set from STACOM 2013 image segmentation challenge, providing a bias-free evaluation framework for LA and PPV segmentation and volume measurements. The dataset includes 10 training MR volumes with labeled LA and PPVs by expert radiologists through their manual annotations. MR images were obtained from a 1.5T Achieva (Philips Healthcare, The Netherlands), ECG-gated 3D balanced steady-state free precession acquisition, TR/TE = 4.4/2.4 ms, and Flip-angle = 90. In-plane resolution was 1.25×1.25 mm2, slice thickness was 2.7 mm. Our proposed method is novel and based on a deep convolutional neural network (CNN) with a new loss function (Fig 1A). We utilized three different views of the MRI with separate deep learning strategy to make the computational cost manageable (Fig 1B). We artificially increased the number of training samples to solve the need of big data in CNN training (~60,000 2D MRI slices were adapted in our case). After fusing three different networks coming from different views of MRI, we used the sensitivity, specificity, dice index (DI) and surface-to-surface (S2S) distances to measure segmentation performance.

RESULTS

The STACOM 13 challenge provided bias-free evaluation of the proposed method as follows: the proposed method takes only 10 seconds to segment the LA on the GPU and 7.5 minutes on CPU. The DI and S2S metrics for the LA and PPVs using our proposed method were 95.1%, 68.5%, 1.045 mm, and 1.427 mm, respectively (Fig 1C). This outperforms all the other methods in the literature and has similar to expert-human level performance in accuracy, and better than human-level-performance in efficiency.

CONCLUSION

We have designed a deep learning based segmentation method to accurately calculate the LA and PPVs volumes. This will prove particularly useful in mapping the LA and PPVs prior to ablation procedures used to treat atrial fibrillation. Compared to expert human-level performance, the proposed method achieved a high level of accuracy and efficiency.

CLINICAL RELEVANCE/APPLICATION

The proposed computer algorithm has great potential in the clinical applications of cardiac diseases, specifically in mapping of the LA and PPVs prior to ablation for treatment of atrial fibrillation.

SSA04

Cardiac (Coronary Artery Disease and Fractional Flow Reserve)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S504AB

CA CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

James C. Carr, MD, Chicago, IL (*Moderator*) Research Grant, Astellas Group; Research support, Siemens AG; Speaker, Siemens AG; Advisory Board, Guerbet SA
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Sub-Events

SSA04-01 Impact of CT FFR on Reader Confidence for CCTA Studies

Sunday, Nov. 26 10:45AM - 10:55AM Room: S504AB

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PURPOSE

To investigate whether reader confidence for characterization of coronary artery disease (CAD) improved when fractional flow reserve (CTFFR) calculated from cardiac computed tomography angiography (CCTA) was read in conjunction with anatomic CCTA.

METHOD AND MATERIALS

This IRB approved HIPAA compliant quality assessment study included 50 patients (27 male, age 67±12 years, BMI 28.7±5.3km/m^2). CCTA was acquired on a 3rd generation dual source MDCT (Siemens Force, Forchheim, Germany). FFR-CT was calculated (HeartFlow, Redwood City, CA). Four readers with 0.5, 1.5, 6, and 10 years of CCTA experience assessed each dataset twice, with CCTA only and with CCTA and FFR-CT data. Reader confidence to diagnose CAD and exclude hemodynamically significant stenosis (HS) were rated on a 4-point scale (1= high, 2=good , 3=moderate, and 4= not confident) for 4 coronary artery segments (CAS): left main (LM) left anterior descending (LAD), left circumflex (LCX), and right coronary artery (RCA). Time to interpret each examination was recorded. Non-parametric statistics were utilized.

RESULTS

Eight hundred CAS were evaluated. 15, 8, 11, and 16 cases were CAD RAD 1, 2, 3 and 4a, respectively. 64 VS in 33 cases had a stenosis with an FFR-CT values <0.8. Reader confidence increased significantly for CAD and HS (p=0.0001) with an improvement in 93 (11.6%) and 190 (23.8%) CAS and a decline in 27 (3.4%) and 32 (4%) CAS, respectively. The median change in level of confidence was -1 (range -3 to 2) and -2 (range -3 to 2) for CAD and HS, respectively. For the VS, we observed the highest increase of confidence to exclude HS for the LAD (p<0.0001), RCA (p<0.0001) LCX (p<0.0001), and LM (p<0.0001) with median changes of -2 (-3 to 2), -1 (-3 to 2), -1 (-3 to 2), and -1 (-3 to 1), respectively. Readers with more than 5 years' experience did not report a significant improvement of confidence for CAD (p=0.11), but all levels of experience showed an improved confidence to exclude HS (p<0.0001). The time to read CCTA exam decreased with availability of FFR-CT from 10.7±4.5 min to 8.4±3.8 min per case(p<0.0001).

CONCLUSION

CCTA with FFR-CT increased reader confidence to diagnose CAD and exclude HS. Interpretation of CCTA with FFR-CT reduced reading time. Change in reader confidence was observed to a greater degree with less experienced readers.

CLINICAL RELEVANCE/APPLICATION

CT based FFR improves reader confidence to diagnose coronary artery disease and reduces reading time.

SSA04-02 Endothelial Shear Stress (ESS) Measured from Coronary CT Angiography (CTA) Is Associated with Impaired Fractional Flow Reserve (FFR) Independently of Atherosclerotic Plaque Burden In Coronaries with Lesions of Intermediate Stenosis Severity

Sunday, Nov. 26 10:55AM - 11:05AM Room: S504AB

Participants
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PURPOSE

CTA plaque burden has recently been associated with lesion-specific ischemia. ESS modulates plaque progression and development of high-risk plaque features. It is also a key factor controlling flow-mediated dilation (FMD) to accommodate flow demands, such as in hyperemia. Thus, although pathobiology suggests a causal link of ESS to lesion-specific ischemia, their association has not been adequately explored to date. We assessed if ESS and plaque burden measured from CTA are associated with FFR<=0.8 in intermediate lesions.

METHOD AND MATERIALS

61 consecutive adults with clinically-indicated CTA and FFR in 90d in a 30-69% diameter stenosis (DS) lesion were retrospectively analyzed. Resting-state ESS was calculated from CTA using computational fluid dynamics (non-Newtonian blood, flow based on myocardial mass, flow distribution using Murray's law). Average ESS was measured in the 5mm proximal and distal to, and the 10mm around the center of each lesion for which FFR was measured. Plaque volume (%PV=% of wall tissue) in those vessels and lesion %DS were measured from CTA (Medis QAngio CT). Univariate logistic regression and receiver operating characteristic curve area (AUC) identified parameters associated with FFR<=0.8. Significantly-associated parameters were used in a multivariate model to determine independent association to FFR<=0.8.

RESULTS

25 lesions had FFR<=0.8 (41%). AUC to detect FFR<=0.8 was 0.62 for CTA %DS, 0.78 for %PV, and 0.70, 0.78 and 0.81 for proximal-, central-, and distal-to-lesion center ESS, respectively. In univariate analysis only %PV (p=0.02) and ESS were associated with FFR<=0.8 (p=0.02, 0.01, and 0.01). In multivariate analysis, ESS in the 5mm distal to the plaque center was independently associated with FFR<=0.8 (p=0.017). High ESS>5.4 Pa in that plaque location detected FFR<=0.8 with sensitivity, specificity, and overall accuracy of 77.3%, 76.9%, and 77%, respectively.

CONCLUSION

High resting ESS distal to the plaque center and plaque burden are associated with lesion-specific ischemia. We posit that high ESS and plaque burden affect FMD pathways, impairing a vessel's ability to dilate to accommodate hyperemic flow.

CLINICAL RELEVANCE/APPLICATION

ESS from rest CTA does not require simulating hyperemia and predicts lesion-specific ischemia (FFR<=0.8) independent of plaque burden, implying endothelial function is linked to inducible ischemia.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Frank J. Rybicki III, MD, PhD - 2016 Honored Educator

SSA04-03 Association of Image and Lesion Characteristics to the Magnitude of the Deviation of a Novel, Open Fractional Flow Reserve (FFR) from Computed Tomography Angiography (CT-FFR) Technique from Gold-Standard Invasive FFR Measurements

Sunday, Nov. 26 11:05AM - 11:15AM Room: S504AB

Awards
Trainee Research Prize - Medical Student

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PURPOSE

Multiple CT-FFR techniques have been reported with excellent accuracy to detect hemodynamically significant lesions (invasive FFR<=0.8). However, limitations remain, with eg, the recent NXT trial excluding 13% of CTAs from FFRCT (HeartFlow) analysis solely due to image quality. We previously validated a CT-FFR algorithm that can be performed with or without a proprietary basis (RSNA 2016). We sought to assess whether image quality and lesion characteristics affect the diagnostic accuracy of this novel

CT-FFR algorithm.

METHOD AND MATERIALS

61 consecutive patients with clinically-indicated CTA and FFR in <90d in a vessel with 30-69% diameter stenosis by CTA were retrospectively analyzed. CT-FFR was calculated using a previously validated technique. We measured CTA (a) vascular signal-to-noise (SNR) and contrast-to-noise (CNR) from Housfield units in the aorta, coronary ostia, and proximal coronaries, (b) minimum vessel caliber (diameter, area) in and around the FFR-interrogated lesion, and (c) lesion location (proximal, mid, distal) and (d) lesion characteristics (calcified, complex, non-calcified). We assessed the relationship of independent variables (a)-(d) to dependent variables of (1) absolute difference between invasive FFR and CT-FFR (=FFR), and (2) binary determination of lesion significance (agreement of <=0.8 for CT-FFR and invasive FFR), using linear regression, t-test, ANOVA, chi-squared, and Fisher exact tests as appropriate.

RESULTS

Of the parameters tested, the following had significant associations: larger in-lesion minimum lumen area was correlated with reduced FFR (=-0.28; Std.Err.=0.11; p=0.03) and increased odds of binary decision agreement (=0.88; S.E.=0.42; p=0.04); larger vessel caliber proximal to the lesion was correlated with increased odds of binary agreement (=0.34; S.E.=0.13; p=0.01); and higher ascending aorta SNR was correlated with increased FFR (=0.26; S.E.=0.11; p=0.04).

CONCLUSION

In intermediate lesions, higher aorta SNR and smaller vessel caliber increase the absolute error of CT-FFR estimates, and smaller vessel caliber reduces agreement between CT-FFR<=0.8 and invasive FFR<=0.8. We posit the counter-intuitive loss of accuracy at higher SNR is due to increased contrast load obscuring the lumen vs calcified plaque

CLINICAL RELEVANCE/APPLICATION

Image quality and lesion characteristics may impact the diagnostic performance of CT-FFR for lesions of intermediate stenosis severity

SSA04-04 Non-invasive Rapid On-site Estimation of CT Angiography Derived Fractional Flow Reserve Using a Lumped Parametric Model: Initial Experience

Sunday, Nov. 26 11:15AM - 11:25AM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

To investigate the feasibility and accuracy of a novel method to estimate fractional flow reserve (FFR) from coronary computed tomography angiography (CCTA) images based on lumped parametric models and to compare the accuracy of the new method to evaluation of degree of stenosis only.

METHOD AND MATERIALS

Twenty-five patients (36% female) who underwent CCTA and subsequent catheter based invasive FFR within 90 days were retrospectively selected. An FFR value <=0.8 was used to define functionally significant stenosis. Diagnostic performance of FFRct was evaluated and compared to performance of stenosis degree reported on CCTA. Invasively measured FFR served as the standard of reference in all subjects. For FFRct an observer, blinded for FFR outcome, extracted the coronary lumen semi-automatically using prototype software based on patient-specific lumped parameter models. Subsequently, location of FFRct was matched with catheter based FFR and FFRct was computed.

RESULTS

Catheter based FFR was performed in 39 coronary arteries and indicated significant stenosis in 16 arteries (12 patients). Analysis of stenosis degree on CCTA resulted in an area under the receiver operator curve (AUC) of 0.61 (95% confidence interval [CI]: 0.44-0.79) on a vessel basis and 0.55 (95%CI: 0.32-0.78) on a patient basis. A cutoff value of >50% to indicate significant stenosis resulted in sensitivity and specificity of 81% and 43% on a vessel basis and 83% and 23% on a patient basis. Use of FFRct improved performance substantially, with AUCs of 0.79 (95%CI: 0.65-0.93) and 0.82 (95%CI: 0.66-0.99), respectively. A cutoff value of <=0.8 resulted in sensitivity and specificity of 81% and 70% on a vessel basis and 92% and 69% on patient basis. Total runtime to calculate the FFRct value after completion of segmentation was <10 seconds.

CONCLUSION

Our preliminary results show that rapid on-site FFRct is feasible with high diagnostic performance and offers an incremental value over stenosis degree evaluation on CCTA alone for the detection of functionally significant stenosis. The method is fast, can be performed on-site and obviates the need for high computational power.

CLINICAL RELEVANCE/APPLICATION

Rapid on-site FFRct has the ability to increase the specificity of CCTA, thereby potentially reducing the number of patients unnecessarily referred for catheter based FFR.

SSA04-05 A Novel Quantitative CT Angiography Index: Based On the Amount of Myocardium Subtended By Stenosis and Minimal Lumen Diameter Correlates with Fractional Flow Reserve

Sunday, Nov. 26 11:25AM - 11:35AM Room: S504AB

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PURPOSE

To study the diagnostic performance of the ratio of Duke jeopardy score (DJS) to the minimal lumen diameter (MLD) at coronary computed tomographic angiography (CTA) for differentiating functionally significant between nonsignificant lesions, with reference to fractional flow reserve (FFR).

METHOD AND MATERIALS

Patients who underwent both coronary CTA and FFR measurement at invasive coronary angiography (ICA) within 2 weeks were retrospectively included in our study. DJS/MLDCT ratio, along with other parameters, including minimal luminal area (MLA), MLD, lesion length (LL), diameter stenosis, area stenosis, plaque burden, remodeling index, and quantitative coronary angiography (QCA) of lesions, were recorded. Lesions with FFRs <= 0.8 were considered to be functionally significant.

RESULTS

Seventy-two patients with 82 lesions were ultimately included for analysis. The LL, diameter stenosis, area stenosis, plaque burden, QCA, DJS and DJS/MLDCT ratio were all significantly longer or larger in the group of FFR <= 0.8 ($p < 0.05$ for all), while smaller MLA and MLD were also noted ($p < 0.001$ for both). ROC curve analysis determined the best cut-off value of DJS/MLDCT ratio as 2.04 (area under curve =0.866, 95 % confidence interval = 0.773-0.931), which yielded high diagnostic accuracy (84.1%, 69/82).

CONCLUSION

The DJS/MLDCT ratio, as characterized by using coronary CT angiography, correlates well with FFR measurements and is associated with the hemodynamically coronary stenosis.

CLINICAL RELEVANCE/APPLICATION

DJS/MLDCT ratio was an easy-to-calculate CT parameter and significantly higher in hemodynamically significant coronary lesions. DJS/MLDCT ratio has the best diagnostic performance compared to other traditional CT and invasive coronary angiography parameters. This novel index might help to non-invasively identify the hemodynamically signigicant lesions.

SSA04-06 The Effect of Sublingual Nitroglycerine on the Diagnostic Accuracy of Machine Learning-Based Coronary CT Angiography-Derived Fractional Flow Reserve

Sunday, Nov. 26 11:35AM - 11:45AM Room: S504AB

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PURPOSE

This study investigated the effect of sublingual nitroglycerine on the diagnostic accuracy of machine learning-based coronary CT angiography (CCTA)-derived fractional flow reserve (CT-FFR).

METHOD AND MATERIALS

This bi-centric retrospective investigation included 73 patients (61±12 years, 74% male) and 119 vessels from Europe and the United States. All patients had undergone a clinically indicated first or second generation dual-source CCTA study followed by invasive coronary angiography (ICA) with at least one invasive fractional flow reserve (FFR) measurement. Patients were divided into two groups (Gr): patients who were administered pre-CCTA sublingual nitroglycerine (Grnitro) and patients who were not administered any drugs prior to CCTA (Grnone). CCTA datasets were evaluated using an onsite, workstation-based machine learning CT-FFR prototype (Frontier, Siemens) to assess lesion-specific ischemia. Performance characteristics (accuracy, sensitivity, and specificity) and a receiver operating characteristics (ROC) analysis of the CT-FFR prototype to detect lesion-specific ischemia (defined as CT-FFR <=0.80) were evaluated in each group on a per-patient and per-lesion level, with invasive FFR as the reference standard.

RESULTS

The per-patient analysis in Grnitro and Grnone showed similar overall accuracy (87% vs. 89%), sensitivity (90% vs. 89%) and specificity (78% vs. 88%), respectively. The per-lesion analysis in Grnitro and Grnone also revealed similar accuracy (81% vs. 88%), sensitivity (82% vs. 93%) and specificity (80% vs. 85%), respectively. On a per-lesion level, the Area Under the ROC Curve (AUC) for CT-FFR Grnitro (0.85) and Grnone (0.88) showed similar discriminatory power for detecting lesion-specific ischemia with no statistical difference between the ROC curves (P=0.65).

CONCLUSION

This investigation revealed similar performance characteristics and discriminatory power for CT-FFR to detect lesion specific ischemia in patients who were and were not administered pre-CCTA sublingual nitroglycerine.

CLINICAL RELEVANCE/APPLICATION

Pre-CCTA nitroglycerine may not be an absolute requirement to ensure the accuracy of CT-FFR estimates for detecting lesion-specific ischemia. Ultimately accurate CT-FFR evaluations may thus be obtained in an expanded patient population and with a simplified workflow.

SSA04-07 Effect of Coronary Artery Calcium on the Diagnostic Performance of Machine Learning-Based Coronary CT Angiography-Derived Fractional Flow Reserve: Results from the Machine Registry

Sunday, Nov. 26 11:45AM - 11:55AM Room: S504AB

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PURPOSE

To investigate the effect of coronary artery calcium on the diagnostic performance of on-site machine learning coronary CT angiography (cCTA)-derived fractional flow reserve (CT-FFR).

METHOD AND MATERIALS

481 vessels in 314 patients (62.3+/-9.3 years, 74% male) who had undergone cCTA followed by invasive fractional flow reserve (FFR) measurement were enrolled in this sub-study of the MACHINE registry (Machine leArning based CT angiograpHy derIved FFR: a Multi-ceNtEr Registry). Coronary artery calcium was quantified using the Agatston convention. The diagnostic performance of a prototype deep machine-learning on-site CT-FFR algorithm (Frontier, Siemens) to detect lesion-specific ischemia was assessed across all Agatston score quartiles (Q1- Q4), in low to intermediate (Q1- Q3), and high Agatston scores (Q4) on a per-patient and per-vessel level with invasive FFR as the reference standard.

RESULTS

Median Agatston scores on a per-vessel and per-patient level were 76 (range 0-2066) and 238 (range 0-3920), respectively. The diagnostic accuracy of CT-FFR was superior to that of cCTA on a per-vessel (78% vs. 58%) and per patient (83% vs. 73%) level across all Agatston score quartiles. No statistically significant differences in diagnostic accuracy, sensitivity, or specificity of CT-FFR were observed across Agatston sore quartiles. CT-FFR demonstrated superior discriminatory power in vessels with high Agatston scores (250 to 2066) and low-intermediate Agatston scores (0 to 249) without a statistically significant difference in the area under the receiver-operating characteristic curve (AUC) (AUC: 0.77 [95%CI 0.68-0.86] vs. 0.86 [95%CI 0.82-0.90], p=0.76). CT-FFR showed incremental diagnostic power over cCTA alone (AUC 0.55 and AUC 0.66; both p<0.001) in vessels with high Agatston scores (AUC 0.77) and low to intermediate Agatston scores (AUC 0.86).

CONCLUSION

Machine learning CT-FFR demonstrated superior diagnostic performance over cCTA alone across all Agatston score quartiles both on a per-lesion and per-patient level with no difference between patients with low to intermediate and with high Agatston scores.

CLINICAL RELEVANCE/APPLICATION

CT-FFR has excellent diagnostic performance across all Agatston score quartiles which could facilitate its integration into clinical decision making trees for coronary artery disease management. This is of particular relevance in patients where cCTA specificity is impaired by heavy calcifications.

SSA04-08 Accuracy of Coronary Computed Tomographic Angiography to Detect Obstructive Coronary Artery Disease by Using Stress versus Rest Dataset in Patients Referred to Stress Computed Tomographic Perfusion

Sunday, Nov. 26 11:55AM - 12:05PM Room: S504AB

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PURPOSE

The combined evaluation with coronary computed tomographic angiography (CCTA) and stress computed tomographic perfusion (CTP) is emerging as a robust tool to provide anatomical and functional information in intermediate to high risk patients with suspected coronary artery disease (CAD). We sought to compare the diagnostic accuracy of CCTA to detect obstructive CAD between stress versus rest dataset as compared to invasive coronary angiography (ICA).

METHOD AND MATERIALS

Seventy-six consecutive symptomatic patients [mean age: 65±9 years, male 64%] with intermediate to high pre-test probability of CAD and scheduled for clinically indicated ICA, were prospectively enrolled. All patients underwent rest-CCTA followed by stress-CTP protocol with adenosine (Revolution CT Scanner, GE Healthcare, Milwaukee, WI) with injection of 70 ml of Iodixanol 320 (Visipaque 320 mg/ml, GE Healthcare, Oslo, Norway). For both datasets, the image quality was evaluated with Likert score. The severity of coronary lesions was quantified in multi-planar curved reformatted images by identifying the minimum diameter and reference diameter for all stenoses, and the percentage of stenosis was derived according to the following formula: (Dref - Dmin)/Dref ·100, where Dref is the reference diameter and Dmin is the minimum diameter. For CCTA and ICA, the obstructive CAD was defined as the presence of coronary artery stenosis>=50%.

RESULTS

Obstructive CAD was found in 61% (46/76) of patients at ICA. In a vessel-based model, the stress dataset showed a higher heart rate as compared to the rest dataset (76±14 vs 62±9 bpm, p<0.001) with similar image quality. The stress dataset showed similar sensitivity (95% vs. 93%) but slight lower specificity (75% vs. 80%, p:0.05] as compared to rest dataset. However, in both vessel and patient based model, stress and rest dataset showed similar area under the curve (AUC) (0.84 vs.0.82 and 0.84 vs. 0.84).

CONCLUSION

In static stress CTP, the new generation scanner allows to perform the coronary artery imaging in the stress dataset with the same accuracy of rest dataset. This preliminary evidence opens the potential scenario to perform a single stress acquisition providing anatomical and functional information without the need of additional scan.

CLINICAL RELEVANCE/APPLICATION

Our evidences open the potential scenario to perform a single stress CT acquisition providing anatomical and functional information without the need of additional scan.

SSA04-09 Coronary CT Angiography-Derived Fractional Flow Reserve for Therapeutic Decision Making

Sunday, Nov. 26 12:05PM - 12:15PM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

To investigate the performance of coronary CT angiography (cCTA) with cCTA-derived fractional flow reserve (CT-FFR) compared to invasive coronary angiography (ICA) with fractional flow reserve (FFR) for therapeutic decision-making in patients with suspected coronary artery disease (CAD).

METHOD AND MATERIALS

We retrospectively evaluated 74 patients (62.2±10.6 years, 62% male) with at least one coronary stenosis >=50% on clinically indicated dual-source cCTA who had subsequently undergone ICA with FFR measurement. CT-FFR values were computed using an on-site machine-learning algorithm (Frontier, Siemens) to assess the functional significance of CAD. The therapeutic strategy (optimal medical therapy alone versus revascularization) and appropriate revascularization procedure (percutaneous coronary intervention [PCI] versus coronary artery bypass grafting [CABG]) was selected using cCTA/CT-FFR. Accuracy and test characteristics for functionally significant CAD and therapeutic strategy selection based on cCTA/CT-FFR were calculated, with ICA/FFR-based findings and management as reference standards.

RESULTS

36 patients (49%) had functionally significant CAD based on ICA/FFR. cCTA/CT-FFR correctly identified functionally significant CAD and the need of revascularization in 35 of 36 patients (97%). When revascularization was deemed indicated, the same revascularization procedure (32 PCI and 3 CABG) was chosen in 35 out of 35 patients (100%). Overall, identical management strategies were selected in 73 of the 74 patients (99%).

CONCLUSION

cCTA/CT-FFR shows excellent performance to identify patients with and without need of revascularization and to select the appropriate revascularization strategy.

CLINICAL RELEVANCE/APPLICATION

cCTA/CT-FFR as a non-invasive "one-stop shop" has the potential to change diagnostic workflows and to directly inform therapeutic decision making in patients with suspected CAD.

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SSA05

Chest (Thoracic Malignancy/Lung)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S404CD

CH OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSA05-01 Radiologists vs Deep Learning System (3D Convolutional Neural Network): Radiological Prediction of Pathological Invasiveness in Lung Adenocarcinoma

Sunday, Nov. 26 10:45AM - 10:55AM Room: S404CD

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PURPOSE

To compare results of radiological prediction of pathological invasiveness(PI) in lung adenocarcinoma among three radiologists and deep learning system.

METHOD AND MATERIALS

This study included 90 patients (M:F=50:40) with 24 cases of adenocarcinoma in situ(AIS, PI=0mm), 20 cases of minimally invasive adenocarcinoma(MIA, PI<=5mm), and 46 cases of invasive adenocarcinoma(IVA, PI>5mm). CT images with 0.625-mm thickness were evaluated. Three radiologists (R1, R2, R3; 7, 8, 25 years of experience) diagnosed each nodule by predicting PI from CT findings: irregular margin, air bronchiologram with disruption and/or irregular dilatation, pleural indentation, and solid component in part-solid nodule(size<=5mm or >5mm). In ground-glass nodule(GGN), a nodule density(dense or inhomogeneous) was evaluated. 3D Convolutional Neural Network (3D-CNN) was used as the deep learning system (DL, Tensorflow ver.0.12.1). Input data size from 3D CT images is 30x30x30 pixels(1601mm^3). The 3D-CNN structure is constructed with 2 successive pairs of convolution and max-pooling layers, and 2 fully-connected layers. The output layer is composed of 3 nodes to recognize the 3 conditions (0=AIS,1=MIA,2=IVA) or 2 nodes for the 2 conditions (0=AIS,1=MIA/IVA). Repeated measures ANOVA and multivariate ROC analysis were used statistically.

RESULTS

90 nodules were 24 AISs(16GGNs, 8part-solids), 20 MIAs(3GGNs, 12part-solids, 5solids), and 46 IVAs(5GGNs, 20part-solids, 21solids). There were no significant differences in accuracy rates with or without PI among DL, R1, R2, and R3: 73.3%, 80%, 74%, and 83.3%. There were no significant differences in pathological diagnostic accuracy rates among DL, R1, R2, and R3: 51.1%, 61.1%, 53.3%, and 64.4%. Area under curves (AUC) of DL, R1, R2, R3 were 0.712(95% confidence intervals[CI], 0.61 to 0.80), 0.665(95%CI, 0.56 to 0.76), 0.574(95%CI, 0.47 to 0.68), and 0.714(95%CI, 0.61 to 0.80). AUCs of DL and R3 were significantly higher than R2 (p=0.039 and 0.026, respectively).

CONCLUSION

Despite small training data, DL showed accuracy rate almost equal to radiologists. AUC of DL was almost the same as the radiologist with much experience, which was significantly higher than the radiologist with small experience.

CLINICAL RELEVANCE/APPLICATION

Deep learning system can predict the PI in lung adenocarcinoma from CT images, resulting in being equal to radiologist with much experience.

SSA05-02 Preoperative Assessment of Parietal Pleural Invasion/Adhesion of Subpleural Lung Cancer: Advantage of Software-Assisted Analysis Using 4-Dimensional Dynamic-Ventilation CT

Sunday, Nov. 26 10:55AM - 11:05AM Room: S404CD

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PURPOSE

Using 4-dimensional (4D) dynamic-ventilatory scanning provided by a 320-row computed tomography (CT) scanner, we aimed to assess parietal pleural invasion and adhesion of peripheral (subpleural) lung cancer.

METHOD AND MATERIALS

Eighteen patients with subpleural lung cancer underwent both dynamic-ventilation CT during free breathing and conventional (static) chest CT as a preoperative assessment. Subsequently, the absence of parietal pleural invasion or adhesion was surgically confirmed in 13 patients, while the presence of parietal pleural invasion or adhesion was surgically confirmed in five patients. Two chest radiologists, who were blinded to patient status, cooperatively evaluated the presence of pleural invasion/adhesion on the chest CT by two different methods: (i) observing conventional (static) high-resolution CT images, reconstructed in the axial, coronal, and sagittal directions; and (ii) observing 4D dynamic-ventilation CT images combined with a colored map created by research software that suggested the absence/presence of pleural invasion/adhesion based on the difference in the movements between the lung surface and chest wall. The parameters of diagnostic accuracy were assessed including a receiver operating characteristic analysis.

RESULTS

For the assessment of pleural invasion/adhesion, observing the software-assisted 4D dynamic-ventilation CT images achieved perfect diagnostic accuracy (sensitivity, 100%; specificity, 100%; area under the curve [AUC], 1.000), in comparison with observing the conventional chest CT (sensitivity, 60%; specificity, 77%; AUC, 0.846).

CONCLUSION

Software-assisted 4D dynamic-ventilation CT can be utilized as a novel imaging approach for accurate preoperative analysis of pleural invasion/adhesion of peripheral lung cancer.

CLINICAL RELEVANCE/APPLICATION

This is the first study to show the clinical utility of software-aided, 4D dynamic-ventilation CT images for the preoperative diagnosis of parietal pleural invasion/adhesion of subpleural lung cancer.

SSA05-03 Reduction of TNM Misstaging in Routine FDG-PET/CT Reports of NSCLC Patients Using Computer-Aided Standardized Label Segmentation

Sunday, Nov. 26 11:05AM - 11:15AM Room: S404CD

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PURPOSE

FDG-PET/CT is the diagnostic standard procedure for staging of NSCLC patients. To date, most hospitals create free-style reports that do not necessarily contain all staging-relevant information. This may lead to misstaging and subsequently erroneous treatment planning. Therefore, we extracted the TNM staging formula from previous free-style PET/CT reports (RIS Stage) and compared these with a segmentation-based approach.

METHOD AND MATERIALS

First, the reports from 145 patients who underwent FDG-PET/CT for primary staging of NSCLC at the University Hospital Basel were extracted from the RIS and TNM (7th edition) stage was determined according to the text information by an experienced radiology and nuclear medicine physician. Next, the corresponding PET and CT image datasets were downloaded from the PACS and transferred to a 3D-slicer-based prototype software that allows for a manual segmentation of tumors, lymph nodes and metastasis using a full set of labels including location information and morphological TNM features.

RESULTS

In a substantial number of patients, not enough information was provided by the report to extract a distinct TNM stage: T: 18.6% (27/145); N: 10.3% (15/145); M: 2.1% (3/145). TNM information could be extracted in all patients with the segmentation-based approach. Furthermore, in 29 cases, there was a considerable discrepancy between the report and annotation: upstaging due the annotations: T: n = 11, N: n = 6, M: n = 4; downstaging due the annotations: T: n = 3; N: n = 4; M: n = 1.

CONCLUSION

We could demonstrate that the proper TNM stage could not be derived from unstructured PET/CT reports in a roughly 30% of the cases . This commonly affects the T-stage because of missing diameter measurements, but also N and M stage. Our approach with tumor labels allows for a clear definition of cancerous lesions in a standardized and reproducible manner.

CLINICAL RELEVANCE/APPLICATION

Labels generated using the proposed approach can be directly translated into clinical decision making such as tumor boards and are less prone to interpretation.

SSA05-04 Computer-Aided Volumetry of the Three-Dimensional Solid Component Size in Part-solid Lung Cancer: Correlation with Prognosis

Sunday, Nov. 26 11:15AM - 11:25AM Room: S404CD

Participants
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PURPOSE

According to the TNM classification of the eighth edition of the UICC, the T factor of a ground-glass nodule is regulated by the size of the solid component within the tumor. The purpose of this study was to investigate the correlation between the postoperative prognosis of patients with part-solid lung cancer and the solid component size acquired using computer-aided three-dimensional (3D) volumetry software on thin-section multi-detector computed tomography (MDCT) images.

METHOD AND MATERIALS

We retrospectively reviewed preoperative MDCT data, surgical records, pathological reports, and postoperative follow-up data of patients with primary lung cancer with ground-glass opacity at our institution from 2013 to 2016, and a total of 92 patients (47 men and 45 women; mean age 66 years) were selected for evaluation. All MDCT data of 0.5-mm thickness were transferred to a 3D workstation, and a chest radiologist measured the maximum solid component size on an axial image (2D-SS) and the 3D maximal solid component size on a multiplanar reconstructed image (3D-SS) within the part-solid nodules. Furthermore, the 3D solid volume (3D-SV) within the nodules was measured using semi-automatic volumetry software. Correlations with postoperative recurrence and disease-free survival (DFS) were compared by receiver operating characteristic (ROC) analysis and a Cox proportional hazards model to assess the predictive values of 2D-SS, 3D-SS, and 3D-SV for prognosis.

RESULTS

For the prediction of postoperative recurrence, the area under the ROC curve was 0.781 for 2D-SS, 0.748 for 3D-SS, and 0.823 for 3D-SV (all $p<0.001$). The optimal cutoff value for 3D-SV for predicting tumor recurrence was 590 mm3, with a sensitivity of 0.923 and specificity of 0.747. According to the multivariate Cox proportional hazards model, the only significant predictive factor for DFS was a 3D-SV > 590 mm3 (hazard ratio 6.03, $p<0.001$).

CONCLUSION

The measurement of 3D-SV using computer-aided 3D volumetry software predicted the postoperative prognosis of patients with part-solid lung cancer more accurately than did 2D-SS or 3D-SS.

CLINICAL RELEVANCE/APPLICATION

3D computer-aided volumetry of primary lung cancer will lead to more accurate prognostic predictions compared with tumor diameter measurement on 2D images, especially for part-solid lung cancer.

SSA05-05 Prediction of the Invasive Component of Lung Adenocarcinoma with Software Segmentation of the Solid Component in Subsolid Nodules: Value of the Vessel Removal Algorithm

Sunday, Nov. 26 11:25AM - 11:35AM Room: S404CD

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PURPOSE

The relationship between the invasive component of lung adenocarcinomas and the solid component of subsolid nodules on CT has been well established. This study aimed to evaluate the value of a vessel removal algorithm in segmentation of subsolid nodules by comparing the measurements of the solid component on CT with the measurement of the invasive component on pathology in lung adenocarcinomas manifesting as subsolid nodules.

METHOD AND MATERIALS

Among 283 cases of surgically resected lung adenocarcinomas, 73 cases which manifested as subsolid nodules on thin-section CT and had the invasive component of <= 10 mm on pathology were selected for analyses. For each nodule, semi-automated segmentation was performed by 2 radiologists and 3D longest, axial longest and effective diameters of solid component were

measured before and after using a vessel removal tool. These measurements were compared with the invasive component diameter on pathology using the paired t-test and Pearson's correlation test.

RESULTS

After removing cases with insufficient segmentation, 68 subsolid nodules were included for statistical analysis. The mean maximal diameter of the invasive component on pathology was 4.6 mm (range, 0 - 10 mm). The correlation between software and pathology measurements was significant ($p<0.01$) and the correlation after vessel removal ($r= 0.49$ to 0.54) was better than before vessel removal ($r=0.27$ to 0.41). The mean measurement difference between solid component on CT and invasive tumor on pathology ranged from 0.73 mm to 2.44 mm before vessel removal and from -1.05 mm to 0.10 mm after vessel removal. The smallest mean measurement difference was obtained with 3D longest diameter of solid component after vessel removal in both readers (-0.26 mm to 0.10 mm), with no significant difference from pathology ($p=0.53$-0.83).

CONCLUSION

By adding a vessel removal algorithm in software segmentation of subsolid nodules, the prediction of invasive component in lung adenocarcinomas can be improved.

CLINICAL RELEVANCE/APPLICATION

Removing pulmonary vessels in segmenting subsolid nodules on CT may lead to a better prediction of the invasive component on pathology and therefore to a better management of such nodules.

SSA05-06 Clinical Application of Quantitative Dual-Energy CT Iodine Maps and CT Morphologic Features in Distinguishing Small Cell Lung Cancer from Non-Small Cell Lung Cancer

Sunday, Nov. 26 11:35AM - 11:45AM Room: S404CD

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PURPOSE

To evaluate prospectively the clinical usefulness of quantitative dual-energy CT (DECT) iodine enhancement metrics combined with morphological CT features in distinguishing small cell lung cancer (SCLC) from non-small cell lung cancer (NSCLC).

METHOD AND MATERIALS

106 consecutive untreated patients (76 men, 30 women; mean age, 61.1 years ± 9.5) were enrolled and underwent DECT before biopsy. A total of 28 conventional CT descriptors were assessed. DECT metrics including Iodine density, iodine ratio and normalized iodine uptake were measured. Multiple logistic regression analyses were applied to identify independent factors of lung cancer subtypes. Two areas under the receiver operating characteristic curve (ROC) were compared.

RESULTS

Histology revealed adenocarcinoma in 44, squamous cell carcinoma (SCC) in 36 and small cell lung cancer (SCLC) in 26 patients. SCLCs were found more frequently in larger ($P=0.014$) and centrally located ($P=0.012$) tumors, tumors with homogeneous enhancement ($P=0.044$), lymphadenopathy ($P=0.038$), confluent mediastinal lymphadenopathy ($P<0.001$), encasement of mediastinal structures($P=0.004$), vascular involvement ($P=0.005$), lung atelectasis and/or obstructive pneumonia ($P=0.019$) and lower iodine density, iodine ratio and normalized iodine uptake (all $Ps<0.01$).NSCLCs were more likely to be with spiculation ($P=0.005$), vascular convergence ($P=0.011$), thickened adjacent bronchovascular bundles ($P=0.017$), and pleural retraction ($P=0.005$).The significantly independent prognostic factors of SCLC were larger tumor size, central location, confluent mediastinal lymphadenopathy, homogeneous enhancement, lower iodine ratio and normalized iodine uptake, and without coarse spiculation when adjusting for pleural retraction and lung atelectasis and/or obstructive pneumonia. ROC curve analysis indicated that use of CT features combined with DECT metrics (area under the ROC curve, AUC =0.981) was significantly superior to use of CT features alone (AUC = 0.908) ($P=0.007$).

CONCLUSION

Quantitative iodine-enhanced metrics generated from DECT in combination with CT features can be used to distinguish SCLC from NSCLC better than use of CT features alone.

CLINICAL RELEVANCE/APPLICATION

DECT can provide both quantitative iodine-enhanced metrics and CT features for discrimination of SCLC from NSCLC and is recommended for clinical use to help initial planning of lung cancer management.

SSA05-07 Comparison of the FDG-PET Avidity of Benign and Malignant Pure Ground Glass Opacities (GGOs): Is Higher FDG-PET Uptake More Typical of Benign GGOs?

Sunday, Nov. 26 11:45AM - 11:55AM Room: S404CD

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PURPOSE

To determine whether 2-[fluorine-18] fluoro-2-deoxy-d-glucose (FDG) PETuptake is higher in benign or malignant GGOs.

METHOD AND MATERIALS

1013 of 2544 total diagnostic PET-CT scans performed in 2011 were randomly selected and retrospectively reviewed to assess for pure GGOs with a mean diameter > 1 cm. 59 GGOs were identified by image review in 40 patients (21F, 19M, mean age 62 yrs, range 22-85 yrs), with a mean of 1.5 GGO per patient, range 1-5. Two observers, blinded to PET findings and final diagnosis, independently reviewed the CT images with respect to location, size, and attenuation (mean Hounsfield units) of GGOs. A third observer, blinded to final diagnosis, analyzed the PET images. A region-of-interest (ROI), inclusive of the entire GGO, was used to measure the maximum standardized uptake value (SUVmax). Final diagnosis of malignancy was made based on pathology, if available, or upon increased size and attenuation; final diagnosis of benignity was made if the GGO resolved, was new compared to a scan performed within the last 3 months, or was stable for at least 60 months; otherwise the GGO was considered indeterminate. The benign and malignant GGOs were compared using a 2-tailed Student's t test.

RESULTS

3 of 59 GGOs were excluded due to less reliable SUV measurements (proximity to adjacent FDG-avid structures). Of the remaining 56 GGOs, 15 GGOs were indeterminate, resulting in a cohort of 41 pure GGOs, 31 benign and 10 malignant. Benign GGOs were significantly larger than malignant ones (average mean diameter 26 mm versus 14 mm, respectively) (p=0.04). The SUVmax was higher in the benign group (mean 2.2; median 1.3; range 0.4-8.8) than the malignant group (mean 0.8; median 0.8; range 0.5-1.4) (p=0.05). With an SUVmax threshold to ensure 100% sensitivity for detection of malignancy, the specificity for the detection of malignancy was 39%. There was no significant difference in mean attenuation (p=0.4).

CONCLUSION

Benign pure GGOs had higher FDG-PET uptake than malignant GGOs. At an SUVmax threshold ensuring 100% sensitivity for malignancy, 39% of benign GGOs could avoid misinterpretation as malignant lesions.

CLINICAL RELEVANCE/APPLICATION

This study shows that higher FDG PET-uptake is much more typical of benign, than malignant, pure GGOs. Awareness of this finding should improve PET-CT interpretation of GGOs and resultant clinical management.

SSA05-08 Histologic Subtypes Are Not Associated with the Presence of Sarcopenia in Lung Cancer

Sunday, Nov. 26 11:55AM - 12:05PM Room: S404CD

Participants
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PURPOSE

Sarcopenia is prevalent and a known adverse prognostic effector in lung cancer (LCA). However, the relationship between sarcopenia and histology remains uncertain in LCA.

METHOD AND MATERIALS

Consecutive patients with newly diagnosed LCA (n=778) between June 2012 and February 2015 were retrospectively reviewed to identify factors associated with sarcopenia. Sarcopenia was defined as CT-determined L3 muscle index (muscle area at L3/height2) of < 55 cm2/m2 for men and < 39 cm2/m2 for women.

RESULTS

Mean patient age was 67.7 ± 10.8 years, and most (73.1%) were male. The most prevalent histology was adenocarcinoma (44.0%) and 71.6% of patients had stage III or IV disease. The overall prevalence of sarcopenia was 48.2% (60.3% in men, and 15.3% in women). Univariable analysis showed sarcopenia was significantly associated with male gender, age (>= 65 years), smoking status, lower BMI (< 23 kg/m2), advanced stage (III and IV), and high comorbidity score (Charlson index >= 3). Furthermore, the prevalence of sarcopenia was higher in squamous cell carcinoma (54.9%) and small cell LCA (56.4%) than in adenocarcinoma (39.8%). Multivariable analyses showed sarcopenia was independently associated with a male gender (odds ratio [OR], 11.13), elderly (OR, 2.02) and low BMI (OR, 6.28), stage IV (OR, 1.98), and high comorbidity (OR, 1.93). However, no significant association was found between histologic subtypes and sarcopenia.

CONCLUSION

In a single center lung cancer cohort, sarcopenia was found to be significantly associated with old age, male gender, an advanced stage, comorbidities, and low BMI in LCA. However, histology subtype was not an independent factor for the presence of sarcopenia.

CLINICAL RELEVANCE/APPLICATION

Understanding of associated factors of sarcopenia might provide better understanding of the mechanism responsible for cancer cachexia in lung cancer.

SSA05-09 Imaging Features Associated with Spread through Air Spaces (STAS) in Patients with Lung Adenocarcinoma

Sunday, Nov. 26 12:05PM - 12:15PM Room: S404CD

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Spread through air spaces (STAS) is a recently recognized pattern of tumor invasion and has been reported to be a predictor of recurrence and survival in lung adenocarcinomas (ADCs). However, there has been no detailed investigation on imaging-based identification of STAS in lung ADC. We aimed to explore the imaging features for predicting STAS in surgically resected lung ADCs.

METHOD AND MATERIALS

Presence of STAS was evaluated in 1,295 surgically resected ADCs from April 2015 to December 2016. STAS-positive and STAS-negative patients were matched 1:2 using patient variables (e.g.: age, sex and smoking status). CT morphologic features (solidity, location, margin, shape, cavity, calcification, central low-attenuation, ill-defined opacity around the tumor, air-bronchogram, satellite lesion, pleural retraction, and percentage of solid portion), and FDG uptake on PET were analyzed by using multivariate logistic regression and receiver operating characteristics (ROC) curve.

RESULTS

STAS was found in 127 (9.7%) of 1295 patients. Ninety-six STAS-positive patients and 188 STAS-negative patients after matching were included in the analyses. STAS was found more frequently in solid tumors (75 of 96, 78.1%) than part-solid (21 of 96, 21.9%) or ground-glass nodules (0 of 96, 0%) (P<0.001). STAS was also found to be associated with central low-attenuation, ill-defined opacity around the tumor, percentage of solid portion and FDG uptake (P<0.001, respectively). Percentage of solid portion was unique independent predictor for the presence of STAS (OR 1.061, 95% C.I. 1.039-1.085) and cut-off value of 90.8% showed good discriminatory power with a sensitivity of 89.6% and a specificity of 61.2%.

CONCLUSION

Percentage of solid portion on CT appears to be a promising imaging biomarker for predicting STAS in lung ADCs, potentially allowing proper management.

CLINICAL RELEVANCE/APPLICATION

CT imaging features of lung ADC can be used to identify the presence of STAS and may help clinicians make better decisions about the exact extent of surgical resection or radiation therapy.

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SSA06

Science Session with Keynote: Emergency Radiology (Cutting Edge Technologies)

Sunday, Nov. 26 10:45AM - 12:15PM Room: N226

CT ER IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Michael N. Patlas, MD, FRCPC, Hamilton, ON (*Moderator*) Nothing to Disclose
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Sub-Events

SSA06-01 Emergency Radiology Keynote Speaker: Machine Learning in Emergency Neuroradiology

Sunday, Nov. 26 10:45AM - 10:55AM Room: N226

Participants
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SSA06-02 Improved Detection and Confidence of Subtle Lung Lesion Using Bone Suppression Imaging Generated By Deep Learning Algorithm in the Emergency Department

Sunday, Nov. 26 10:55AM - 11:05AM Room: N226

Participants
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PURPOSE

To determine whether a standard radiograph aided by the bone suppression imaging (BSI) using deep learning algorithms could improve the radiologists' performance for detection of subtle lung lesions in the emergency department (ED).

METHOD AND MATERIALS

This retrospective study included 160 patients who underwent digital chest radiographs and chest CT in the ED: 80 patients with 227 subtle lung lesions and 80 patients without lung lesion with reference to CT from October, 2016 to March, 2017. Deep learning-trained algorithm, which was based on a state-of-the-art convolutional neural network, was applied to the standard radiographs to create corresponding bone suppression imaging. Eight observers (4 board-certified radiologists and 4 radiology residents) rated their confidence level regarding the presence or absence of subtle lung lesions in two reading sessions with an interval or more than 2 weeks: First, each patient image was evaluated with standard radiographs, and then rerandomized images were read with standard radiographs plus BSI. On a per-lesion basis, receiver operating characteristic (ROC) analysis, sensitivity, specificity, and diagnostic confidence were used to evaluate observer performance.

RESULTS

The average area under the ROC curve (AUC) for all observers was improved from 0.594 with standard radiographs to 0.621 with additional BSI ($p = 0.282$). The sensitivity significantly increased from 0.224 unaided to 0.300 aided by BSI ($p < 0.001$); the specificity significantly decreased from 0.993 to 0.989 ($p = 0.004$). The average diagnostic confidence level with additional BSI significantly increased than that with standard radiographs for all readers except one board-certified radiologist ($p < 0.001$).

CONCLUSION

The use of bone suppression imaging improves the radiologist's performance in the detection of subtle lung lesions on digital chest radiography.

CLINICAL RELEVANCE/APPLICATION

The clinical application of the deep learning-trained algorithm such as bone suppression imaging could helpful in the detection of subtle lung lesions.

SSA06-03 Workflow Evaluation of a New Fully Automated Dual-Energy CT Post-Processing Configuration

Sunday, Nov. 26 11:05AM - 11:15AM Room: N226

Participants
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PURPOSE

To evaluate workflow implications of fully automated Dual Energy CT post-processing on image availability and series timing.

METHOD AND MATERIALS

In our existing DECT post-processing workflow, source high and low kVp datasets are transmitted to a thin-client server (Syngo Via software version VB10, Siemens, Forchheim Germany). For contrast-enhanced abdomen and pelvis CT scans, technologists have been instructed to create axial and coronal iodine overlay and matching virtual non-contrast images for transmission to PACS. We installed a pre-release trial software version (Syngo Via VB20) that simultaneously receives the source datasets, and we configured the server to automatically create and transmit the same DECT series to PACS without user interaction. For the first 95 consecutive contrast enhanced ED abdomen and pelvis CT scans performed immediately after server configuration between 03/23/17 - 03/31/17, we recorded presence of manually and automatically created DECT series in PACS, and the series times (when the final image in the series was created) from the DICOM header for: The DECT source dataset, the last manually processed DECT series, the last automatically processed DECT series, and the last routine image series created by the technologist on the scanner console.

RESULTS

Presence of DECT post-processed image series increased from 23% to 92% between the manual and automated workflows. Median intervals from source image creation to DECT series creation were 18 min manual and 1 min automated. All of the 22 manually processed DECT series were created after the last scanner console series, while 97% (83/86) of the automated DECT series were created before the technologists had finished their work on the console.

CONCLUSION

Incorporation of a fully automated DECT post-processing workflow eliminates additional steps from the technologists, resulting in a marked increase in the proportion of scans containing the desired DECT image series, and a large reduction in processing delays. The proportion of processed scans with DECT images created before the final scanner console reconstruction rises from 0% to 97%, so that DECT post-processing is no longer the rate limiting step in exam completion.

CLINICAL RELEVANCE/APPLICATION

Incorporation of a fully automated Dual Energy CT post-processing workflow has the potential to eliminate barriers that commonly prevent practices from incorporating Dual Energy CT into their clinical routine.

SSA06-04 Optimizing CT Radiation Dose with Model-Based Iterative Reconstruction in Diagnosing Acute Appendicitis

Sunday, Nov. 26 11:15AM - 11:25AM Room: N226

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PURPOSE

To determine CT radiation dose as low as reasonably achievable in diagnosing appendicitis using model-based iterative reconstruction (IR).

METHOD AND MATERIALS

The institutional review board approved this prospective study and informed consent was obtained from each participant. The study protocol was registered to ClinicalTrials.gov (NCT02556983). We included 30 patients (mean age, 27.2 ± 7.6 years; 17 females) undergoing 2-mSv CT for suspected appendicitis. With raw data of original 2-mSv CT scans, CT scans simulating lower doses of 1.5 mSv, 1.0 mSv and 0.5 mSv were generated, using a low-dose simulation tool and the IR. Three step-wise non-inferiority tests were planned, where diagnostic performance of 1.5-mSv, 1.0-mSv and 0.5-mSv CT to 2.0-mSv CT were sequentially compared. Non-inferiority test for the next lower dose was performed only when the prior, higher dose passed the non-inferiority test. The primary endpoints were the pooled area under the curve (AUC) in the receiver operating characteristic analysis in diagnosing appendicitis, for three abdominal radiologists and three non-abdominal radiologists. Non-inferiority was established when the upper bound of the two-sided 95% confidence intervals (CI) for the difference of the pooled AUC lay below the non-inferiority margin, which was predetermined to be 0.06.

RESULTS

For abdominal radiologists, the non-inferiority of 1.5, 1.0, and 0.5-mSv CT to 2.0-mSv CT was sequentially accepted (the difference of 1.5-mSv CT to 2.0-mSv, 0.007 [95% CI, -0.016-0.030]; that of 1.0-mSv CT, 0.003 [95% CI, -0.037-0.044]; that of 0.5-mSv, 0.017 [95% CI, -0.016-0.050]). For non-abdominal radiologists, the non-inferiority of 1.5 and 1.0-mSv CT was sequentially accepted (the difference of 1.5-mSv CT, -0.031 [95% CI, -0.101-0.038]; that of 1.0-mSv CT, -0.017 [95% CI, -0.070-0.035]) but that of 0.5-mSv CT was failed to be proven (the difference of 0.5-mSv, 0.045 [95% CI, -0.071-0.161]).

CONCLUSION

With model-based IR, 0.5-mSv CT showed non-inferior diagnostic performance to 2.0-mSv CT for expert abdominal radiologists. For non-abdominal radiologists, 1.0 mSv was the lowest achievable dose to maintain the diagnostic performance.

CLINICAL RELEVANCE/APPLICATION

Considering the high prevalence of appendicitis and clinical settings where expert radiologists are often unavailable, 1-mSv could be regarded as an acceptable dose in diagnosing appendicitis.

SSA06-05 Dual Energy CT for Routine Imaging of the Abdomen and Pelvis in the ER: Radiation Dose and Image Quality

Sunday, Nov. 26 11:25AM - 11:35AM Room: N226

Participants
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PURPOSE

To determine if dual energy CT (DECT) of the abdomen and pelvis can be performed routinely in the Emergency Department setting with acceptable image quality and radiation dose.

METHOD AND MATERIALS

The study cohort included 40 consecutive single energy portal venous phase contrast enhanced CT (SECT) scans of the abdomen and pelvis, which were compared with 40 consecutive portal venous phase DECT scans of the abdomen and pelvis performed after DECT implementation. All scans were performed on the same scanner (Siemens SOMATOM Definition Flash), and all were reconstructed with iterative reconstruction (SAFIRE, strength 3) with a soft tissue kernel. For each scan, the following data was gathered: demographic variables including age and gender; patient size measurements including weight and effective diameter; scan parameters including kVp, contrast volume injected, contrast agent, pitch, scan time, reference mAs and reconstruction kernel; and radiation dose metrics including CTDIvol and DLP. For each scan, measurements of objective image quality were made including signal, noise, and signal to noise ratio (SNR) of the aorta, main portal vein, liver, spleen, and psoas muscle, as well as noise measurements of retroperitoneal fat and air. Categorical variables were compared between groups with a chi-square test and continuous variables were compared with a t-test.

RESULTS

There was no significant difference between the SECT and DECT cohorts in demographic variables or patient size. Mean CTDIvol was significantly lower with DECT than SECT (10.8 mGy vs. 16.6 mGy, $p < 0.0001$), as was mean DLP (532.3 mGy*cm vs. 757.9 mGy*cm, $p = 0.002$). SNR was significantly higher in the DECT compared with the SECT group for the aorta (13.7 vs. 11.5, $p = 0.02$), main portal vein (14.5 vs. 11.9, $p = 0.006$), liver (11.3 vs. 9.8, $p = 0.04$), and spleen (12.1 vs 9.8, $p = 0.005$); there was no significant difference between groups in SNR of the psoas, or in noise measurements of retroperitoneal fat and air.

CONCLUSION

Dual energy CT can be performed for routine imaging of the abdomen and pelvis in the Emergency Department setting at a lower radiation dose than single energy CT, with a significant increase in many measures of objective image quality.

CLINICAL RELEVANCE/APPLICATION

Dual Energy CT of the abdomen and pelvis can be performed routinely in Emergency Department patients, with preserved image quality and radiation dose.

SSA06-06 Dual Energy/Spectral CT Utilization Rates in the Emergency Radiology Department: Does DECT Add Clinical Value in the Acute Setting?

Sunday, Nov. 26 11:35AM - 11:45AM Room: N226

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PURPOSE

Several papers have been published in recent years on the potential of Dual Energy CT (DECT) applications and how they may add clinical value to routine CT studies. Our study assessed the utilization rates of DECT in the emergency radiology department of a tertiary care hospital and level I trauma center and the clinical value added by dual energy interrogation methods.

METHOD AND MATERIALS

For this retrospective, IRB-approved study, the hospital RIS was queried for all DECT scans performed in the emergency department between January 1, 2016 to December 31, 2016. A total of 3159 DECT were performed and were included in our study. The studies were divided by organ system and the reports were reviewed by Emergency Radiology staff, fellows and residents for mention of DE/spectral interrogation as part of the interpretation of the study. Note was made of the number of times DE/spectral interrogation techniques altered management (by changing the diagnosis or detection of an unexpected, clinically relevant finding), confirmed an observation and increased confidence in the definitive diagnosis, provided additional relevant information or characterized an incidental finding - thus avoiding the need for further investigation.

RESULTS

DE/spectral analysis was utilized in 1497 studies out of 3159 (47.39 %). Utilization rates were highest for the musculoskeletal system (97.8 %) followed by the spine (26.3 %), abdomen and pelvis (19.6 %), head (13 %) and chest (11.8 %). DE/spectral analysis altered management in a significant way 14.7 % of all cases, confirmed suspected observations and increased diagnostic confidence in 13 % of cases, provided relevant information on an observation in 5.7 % of cases and characterized an incidental finding in 1.4 % of all cases.

CONCLUSION

There is a high utilization rate of dual energy analysis in the acute setting, with close to half of all DECT studies undergoing DE interrogation. DE/spectral analysis frequently adds value to the examination by providing information that would have otherwise required additional imaging or other investigations.

CLINICAL RELEVANCE/APPLICATION

Routine utilization of DE/spectral techniques can impact management, improve diagnostic confidence and provide definitive clinically relevant diagnostic information only capable by DECT/spectral techniques.

SSA06-07 Increasing Acuity of ED Patients: An Opportunity for Emergency Radiology

Sunday, Nov. 26 11:45AM - 11:55AM Room: N226

Participants
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PURPOSE

Single payer health systems have adapted 24/7 Emergency Radiology services at a rate lower than that of competitive multiple payer systems. We conducted a 10-year review of 2.3 million patients in our health region to establish whether or not there is increasing opportunity for Emergency Radiology to improve patient care. We focused on demographic differences that may account for heterogeneous access to 24/7 Emergency Radiology.

METHOD AND MATERIALS

We conducted a 10-year multi-centre review of 2.3 million patient encounters in Emergency Departments across our health region. For each encounter, we noted the presenting hospital, calendar year, acuity of patient presentation (based on the CTAS scale, from 1 - most acute to 5 - least acute) and overall patient length of stay. Trends in these parameters were evaluated longitudinally among individual hospitals and comparisons made to averages across the entire health region for specific calendar years.

RESULTS

There has been a significant increase in average acuity of patients presenting to EDs across our health region during the study period (2007-2017). In 2007, 51% of patients presenting to all EDs were considered "acute" by CTAS standards (CTAS 1, 2 or 3) and this increased to an average of 57% in 2017. During this time, our quaternary referral hospital, where 24/7 Emergency Radiology has already been implemented), consistently demonstrated the highest proportion of acute patients, ranging from 58% in 2007 to 68% in 2017. Interestingly, over the study period, there has been a significant increase in acuity of patients presenting to rural hospitals, from 34% in 2007 to 64% in 2017. This may be attributable to increased rates of Trauma.

CONCLUSION

There has been a systematic increase in acuity of patient presentations to EDs at all hospitals in our health region over the past 10 years, creating an opportunity for increased utilization of 24/7 Emergency Radiology services. Interestingly, the highest rate of increase has been in rural hospitals, which now rival our quaternary centre for proportion of acuity, and solutions to meet these patient needs within the confines of our single payer system may be needed.

CLINICAL RELEVANCE/APPLICATION

Increased acuity of patient presentations to EDs across our health region, and particularly in rural areas, has created an environment where 24/7 Emergency Radiology may add clinical value in our single payer health system.

SSA06-08 The Emergency Department and Abdominal Imaging: Quantitative Analysis of the Level of Readability of Online Patient Education Resources

Sunday, Nov. 26 11:55AM - 12:05PM Room: N226

Participants
David R. Hansberry, MD,PhD, Philadelphia, PA (*Presenter*) Nothing to Disclose
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Arpan V. Prabhu, BS, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The widespread availability and ease of access has made the Internet a major source of healthcare information for patients. As per the American Medical Association (AMA), the average American reads at an 8th grade level, and to account for patient diversity, the AMA and National Institutes of Health (NIH) guidelines recommend that consumer healthcare websites be written between a 3rd and 7th grade level. The purpose of this study is to evaluate the level of readability of patient education websites, written for the lay public, pertaining to common abdominal imaging diagnoses and diagnostic test performed in the emergency room.

METHOD AND MATERIALS

Thirteen search terms were Googled and the top 10 links for each term were collected and individually analyzed for their level of readability using 10 quantitative readability scales. The search terms included: abdominal ultrasound, abdominal aortic aneurysm, aortic dissection, appendicitis, cholecystitis, CT abdomen, diverticulitis, ectopic pregnancy, MR angiography, ovarian torsion, pancreatitis, pelvic ultrasound, and pneumoperitoneum. Websites not written exclusively for patients were excluded from the analysis.

RESULTS

Collectively the 130 articles were written at a 12.5 grade level. Only 2 of the 130 articles were written at the NIH and AMA recommended 3rd to 7th grade. Surprisingly, 59% were written at a level that required at least a high school education (greater than 12th grade).

CONCLUSION

There is a clear discordance between the readability level of abdominal imaging diagnoses and diagnostic test performed in the emergency room with the NIH and AMA guidelines. This disconnect may negatively impact patient understanding of such Internet resources contributing to poor health outcomes and thus, should be revised for more widespread understanding by the general populace.

CLINICAL RELEVANCE/APPLICATION

Patients frequently use the Internet as an educational resource; it is therefore imperative that these resources be written no higher than the NIH and AMA recommended 7th grade level to ensure widespread understanding by the average American.

SSA06-09 Dose-Estimation of Pregnant Uterus during a Pulmonary Embolism CT-Protocol: A Simulation

Sunday, Nov. 26 12:05PM - 12:15PM Room: N226

Participants
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PURPOSE

To assess the organ dose of the uterus and fetus, in pregnant patients undergoing a pulmonary CTA using a commercial dose-tracking and simulation software.

METHOD AND MATERIALS

Thirty non-pregnant female patients with suspected pulmonary embolism underwent a contrast enhanced pulmonary CTA on a 3rd generation dual source CT (SOMATOM Force, Siemens Healthcare) in single-energy mode with automatic tube voltage selection and tube current modulation. Total equivalent dose and organ dose of the uterus were automatically calculated using a commercially available dose tracking and simulation software (Radimetrics, Bayer Schering). In addition organ dose of the uterus was simulated for 1st, 2nd and 3rd trimester pregnancies; the organ dose of the fetus was simulated for the last two trimesters.

RESULTS

Median age of the patients acquired and analyzed in the retrospective study was 35 [17 - 42] years. Median CTDIVol and DLP were 3.35 [1.6 - 9.7] mGy and 107.6 [46.2 - 497.4] mGy*cm. Total equivalent dose of the clinical CT-examinations was 2.16 [1.05 - 6.50] mSv with an organ dose of 0.05 [0.013 - 0.27] mSv affecting the uterus. Simulated pregnancies showed a total equivalent dose of 2.73 [1.15 - 8.80] mSv vs. 2.73 [1.18 - 9.05] mSv vs. 2.78 [1.22 - 9.30] mSv ($p < 0.0001$) for 1st vs. 2nd vs. 3rd

trimester, respectively. The organ dose affecting the uterus during simulated pregnancy was 0.06 [0.016 - 0.280] mSv vs. 0.23 [0.041 - 0.890] mSv vs. 0.43 [0.11-1.82] mSv ($p < 0.0001$) for 1st vs. 2nd vs. 3rd trimester, respectively. The organ dose affecting the fetus during the 2nd and 3rd trimester was 0.15 [0.00 - 0.74] mSv and 0.22 [0.06 - 1.04] mSv, respectively ($p < 0.0001$)

CONCLUSION

Simulation data show the CTA to be a safe procedure during pregnancy, with a low scatter radiation to the uterus and the fetus throughout all stages of pregnancy.

CLINICAL RELEVANCE/APPLICATION

Dose simulation suggests the chest pulmonary CTA to be a safe procedure during pregnancy

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSA07

Science Session with Keynote: Gastrointestinal (Focal Pancreas Masses)

Sunday, Nov. 26 10:45AM - 12:15PM Room: E353A

BQ CT GI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Michael A. Blake, MBBCh, Boston, MA (*Moderator*) Editor with royalties, Springer Nature
Eric P. Tamm, MD, Houston, TX (*Moderator*) Institutional Research Grant, General Electric Company

Sub-Events

SSA07-01 Gastrointestinal Keynote Speaker: Imaging Approach to Focal Pancreatic Masses

Sunday, Nov. 26 10:45AM - 10:55AM Room: E353A

Participants
Michael A. Blake, MBBCh, Boston, MA (*Presenter*) Editor with royalties, Springer Nature

SSA07-02 Material-Specific Iodine Images and Optimized Kiloelectron Volt Settings for Better Distinction of Pancreatic Carcinoma Using Dual-Energy CT

Sunday, Nov. 26 10:55AM - 11:05AM Room: E353A

Participants
Lucian Beer, MD,PhD, Vienna, Austria (*Presenter*) Nothing to Disclose
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Helmut R. Ringl, MD, Vienna, Austria (*Abstract Co-Author*) Institutional research collaboration, Siemens AG
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PURPOSE

Computed tomography (CT) has become the modality of choice in the diagnosis, staging, treatment planning, and follow-up of patients with pancreatic tumors. However, due to lack of a visible attenuation difference between the tumor and the adjacent pancreatic parenchyma, in particular ductal adenocarcinomas remain often undetected at CT. Dual-energy CT (DECT) may offer promising postprocessing options for an optimized work-up of patients suspected of pancreatic cancer. The aim of his study was to assess DECT- based material-specific iodine images as well as virtual monoenergetic images (MEI) at different kiloelectron volt (keV) levels for the evaluation of pancreatic cancer.

METHOD AND MATERIALS

This retrospective IRB proved and HIPAA compliant study included 46 patients (27 male, mean age 62±11 years) with pancreatic cancer who had undergone DECT of the abdomen for staging. PEI and four MEI images in 10-keV intervals ranging from 40 to 80 keV were reconstructed and iodine-specific maps were generated. Signal to noise ratio (SNR), contrast to noise ratio (CNR) and tumor to pancreas ratio (TPR) were calculated for all image series. Iodine uptake of normal pancreas parenchyma and tumor tissue was compared. For subjective quality assessment the reconstructions were assessed by two blinded readers in consensus using a 5 point scale (1=markedly limited and 5=excellent).

RESULTS

MEI at 40keV had the highest IQob with significantly higher SNR, CNR and TPR compared to PEI (SNR 26.9 vs. 13.2; CNR 16.8 vs. 4.5; TPR 30.9 vs. 2.1; $p<0.05$). MEI 40 keV and 50 keV imaging series both in the arterial and venous pancreatic parenchymal phase were constantly preferred by the observer over all other series ($p<0.05$). Additionally, using the postprocessed material-specific iodine CT images, pancreatic carcinoma tissue showed significant reduced iodine uptake compared to normal pancreas tissue (2.0 vs 4.8 mg/dL; $p<0.001$).

CONCLUSION

MEI at 40keV and 50 keV provide better IQob and IQsub of pancreatic tumors in comparison to conventional PEI and postprocessed material-specific iodine CT images clearly delineate pancreatic cancers with reduced iodine uptake on iodine maps

CLINICAL RELEVANCE/APPLICATION

In suspicion of pancreatic cancer, DECT using postprocessed MEI and material-specific iodine CT images improves tumor conspicuity and has therefore potential to advance the diagnostic confidence in the assessment of pancreatic tumors.

SSA07-03 CT Prediction of Resectability in Patients with Pancreatic Cancer after Neoadjuvant Therapy Using Image Findings and Texture Analysis

Sunday, Nov. 26 11:05AM - 11:15AM Room: E353A

Participants
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PURPOSE

To assess the utility of CT findings and texture analysis for predicting resectability after neoadjuvant therapy in patients with surgery for pancreatic cancer.

METHOD AND MATERIALS

From 2013 to 2016, among 308 patients, forty-seven patients with pancreatic cancer underwent both neoadjuvant therapy and surgery were included. They underwent neoadjuvant concurrent chemoradiation therapy (CCRT, n=29) or neoadjuvant chemotherapy (ChoT, n=18). All patients performed baseline and preoperative CT. Two reviewers assessed CT findings and resectability (resectable, borderline resectable, unresectable). Residual tumor categorized into no residual tumor (R0) and residual tumor (R1 or R2). We analyzed the relationship between CT findings and R classification. CT texture analysis was performed by PC-based in-house software using baseline and preoperative CT. Texture values obtained by subtracting preoperative CT from baseline CT were analyzed using multivariate logistic regression analysis to identify significant parameter for prediction of resectability.

RESULTS

There were 30 patients without residual tumor (CCRT, n=20; ChoT, n=10) and 17 patients with residual tumor (CCRT, n=9; ChoT, n=8). Considering borderline as resectable tumor, overall accuracy for resectability without residual tumor was 63.8 % and 66.0 % for each reviewer; with CCRT (69.0 %) better accuracy than ChoT group (55.6 % and 61.1%). On the contrary, considering borderline as unresectable tumor, overall accuracy for resectability was 53.2% for all reviewers; with ChoT (61.1%) better accuracy than CCRT group (48.3%). In CT texture analysis, three subtracted texture values were found to be independent predictors of R0 resection; Discrete Compactness (odds ratio [OR]: 686.65, P=.036), GLCM Contrast (OR: 40.21, P=.003) and GLCM Entropy (OR: 1.01, P=.009). Using these variables, the area under the curve (AUC) was 0.833.

CONCLUSION

CT with texture analysis can be useful to predict complete resection after neoadjuvant therapy in pancreatic cancer.

CLINICAL RELEVANCE/APPLICATION

As the accuracy for prediction of complete resection after neoadjuvant therapy in pancreatic cancer using conventional CT findings is still low, texture analysis could be helpful in determining of complete resection after neoadjuvant therapy.

SSA07-04 Radiologic and Clinical Value of Simulation CT for Adjuvant Radiotherapy in Pancreatic Adenocarcinoma

Sunday, Nov. 26 11:15AM - 11:25AM Room: E353A

Participants
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PURPOSE

The purpose of this study is to assess radiologic and clinical values of simulation CT scans obtained to plan optimal radiation field before adjuvant radiation therapy for pancreatic adenocarcinoma (PDCA) after curative resection.

METHOD AND MATERIALS

In this retrospective study, 73 patients (51 males, 28 females; median age, 61 years; range, 35-78 years) who had undergone simulation CT scans for adjuvant radiation therapy within 4-8 weeks after surgical resection for PDCA were enrolled. Simulation CT scans covering lower chest to lower abdomen were obtained 70 seconds after the injection of IV contrast media on a multidetector CT scanner with slice thickness of 5 mm. Diagnostic reporting of simulation CT scans had not been established as a routine radiotherapy planning process. Two abdominal radiologists reviewed all simulation CT scans and their immediately prior diagnostic CT scans to identify new cancer-related findings of (1) distant metastasis, (2) locoregional recurrence, and (3) indeterminate lesions. Indeterminate lesions were further reviewed for malignancy and benignity based on additional evaluation and/or follow-ups.

RESULTS

Of 73 patients, distant metastasis, locoregional recurrence, and indeterminate lesions were found in 4 (5.5%), 5 (6.8%), and 32

patients (43.8%), respectively. Among 32 indeterminate lesions, 24 (75.0%) were soft tissue lesions neighboring the SMV. Follow-up PET-CT and diagnostic CT scans revealed 43.7% of indeterminate lesions were malignant representing local failures. The 3-year overall survival was significantly higher in patients without cancer-related findings than in who had such findings (44.8% vs 10.8%, p = 0.002). Potentially significant benign findings were identified in 21 (28.8%) patients, with pseudocysts (52.4%) being the most common followed by venous thrombus, intraabdominal abscess, and ascites.

CONCLUSION

Radiologic review of simulation CT scans have ample diagnostic value as they help detect early progressions or potential failures in patients planned to undergo adjuvant radiation therapy for PDCA. Simulation CT scans should be carefully reviewed before the delivery of adjuvant radiation therapy.

CLINICAL RELEVANCE/APPLICATION

Simulation CT scans for adjuvant radiotherapy in PDCA should be meticulously reviewed by radiologists to identify distant metastasis, locoregional failure, and indeterminate lesions that can modify treatment plan and follow-up plans.

SSA07-05 Prognostic Value of CT Radiomic Features in Pancreatic Ductal Adenocarcinoma: A Study Across Two Centers

Sunday, Nov. 26 11:25AM - 11:35AM Room: E353A

Participants
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PURPOSE

Quantitative radiomic features have shown early promise in predicting outcome in different cancers but limited research has been done on their prognostic value in pancreatic ductal adenocarcinoma (PDAC). The purpose of this study was to assess the prognostic value of CT-derived radiomic biomarkers for PDAC in two separate pre-operative cohorts.

METHOD AND MATERIALS

In this retrospective research ethics board approved study, two cohorts from two institutions, cohorts 1 and 2, consisting of 30 and 69 patients undergoing curative intent surgical resection for PDAC from 2007-2012 and 2008-2013, respectively, were studied. Tumour regions on pre-operative contrast enhanced CT images were manually contoured using in-house software (ProCanVAS). For cohort 1, 160 quantitative features including first and second order statistical features (e.g., gray-level co-occurrence and run-length matrices) and edge detectors (e.g., Kirsch filter) were calculated. Univariate Cox regression analysis was performed to measure the association of these features with overall survival (OS). Those significant radiomic features (i.e., $p<0.05$) identified in cohort 1 were then assessed in cohort 2 and used in a separate Cox regression test to evaluate whether they remain prognostic for cohort 2.

RESULTS

Univariate Cox regression analysis showed that 5 second-order texture features of tumour were predictive of OS in cohort 1: contrast (p=0.027), dissimilarity (p=0.039), difference variance (p=0.027), inverse difference (p=0.042), and inverse difference moment or homogeneity (p=0.027). These radiomic features were also calculated for cohort 2 and all 5 features remained significant after multi-testing correction (false discovery rate) was applied: contrast (p=0.040), dissimilarity (p=0.039), difference variance (p=0.040), inverse difference (p=0.041), and inverse difference moment (p=0.041).

CONCLUSION

CT based radiomic features show promise for prediction of overall survival for PDAC patients undergoing surgical resection across different institutions.

CLINICAL RELEVANCE/APPLICATION

Radiomic features have the potential to risk stratify PDAC patients, potentially guiding the use of neoadjuvant treatment in some patients. Further multicenter validation in larger cohorts is required.

SSA07-06 Quantitative CT-Derived Texture Analysis: A Novel Imaging Biomarker for Assessment and Predication of Response to Neoadjuvant Chemotherapy in Patient with Stage I/II Pancreatic Ductal Adenocarcinoma (PanCA)

Sunday, Nov. 26 11:35AM - 11:45AM Room: E353A

Awards
Student Travel Stipend Award

Participants
Rohit Dewan, DO, Pittsburgh, PA (*Presenter*) Nothing to Disclose
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Amir Borhani, MD, Pittsburgh, PA (*Abstract Co-Author*) Consultant, Guerbet SA; Author, Reed Elsevier

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PURPOSE

Imaging biomarkers that may predict PanCA neoadjuvant chemotherapy response are lacking. We sought to determine if CT-derived textural features correlated with histologic and biochemical markers of treatment response in patients with PanCA.

METHOD AND MATERIALS

29 patients with stage I/II PanCA, who had a discrete pancreatic mass >1cm, were prospectively evaluated. CT, with similar technique, was performed before and after neoadjuvant chemotherapy with gemcitabine and nab Paclitacel +/- hydroxychloroquine. Surgical resection was performed <5 days following the second CT. Late arterial phase images were used for image analysis. A ROI was placed on the largest tumor cross section. CT textural features were extracted using commercially available software (TexRAD) which applies a 2-step filtration-histogram approach. Statistical and histogram-shape parameters were extracted before and following the application of different levels of filtration (2, 4, & 6mm), to enhance features of different size objects within the lesion. Surgical specimen were assessed for tumor histologic respone using the Evans grading system (I:no or minimal response;IV: complete response). A biochemical response was defined as >50% drop in CA-19-9 level. Correlation between textural parameters, tumor grade, Evans grade, and biochemical response was assesses using Pearson and Mann-Whitney U tests. Area under curve (AUC) for ROC curves was calculated. A *p* level of <0.05 was considered statistically significant.

RESULTS

A statistically significant correlation was shown between tumor entropy, skewness, and mean positive pixel on initial CT scan and Evans grade of histological response (r=0.448, 0.496, & 0.415; p<0.05). Tumor entropy and SD on post-treatment CT as well as changes in tumor skewness correlated with Evans grade (r=0.389, 0.436, & -0.417; p<0.05). Changes in tumor kurtosis and skewness also correlated with biochemical response (p=0.014 & 0.011). Texture parameters had a better AUC compared to CA-19-9 for prediction of histological response (0.865 vs 0.625).

CONCLUSION

Quantitative parameters of tumor heterogeneity on baseline CT can predict a response to neoadjuvant chemotherapy in patients with stage I/II PanCA and are better predictors of treatment effect than CA19-9.

CLINICAL RELEVANCE/APPLICATION

PanCA tumor heterogeneity is a useful imaging biomarker for predicting the responce to neoadjuvant chemotherapy.

SSA07-07 Assessment of Response to Chemotherapy in Pancreatic Cancer: Histogram Analysis of Iodine Concentration and CT number in Single-Source Dual-Energy CT-Preliminary Results

Sunday, Nov. 26 11:45AM - 11:55AM Room: E353A

Participants
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Masayuki Matsuo, Gifu, Japan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the feasibility of histogram analysis of iodine concentration and CT number in single-source dual-energy computed tomography (DECT) for the assessment of response to first-line chemotherapy in patients with pancreatic ductal adenocarcinoma (PDAC).

METHOD AND MATERIALS

This prospective study was approved by our IRB and written informed consent was waived. Forty-three consecutive patients with PDAC who were received first-line chemotherapy underwent DECT during pancreatic parenchymal phase (PPP) and equilibrium phase (EP). The iodine concentration and CT number of PDAC were measured on PPP and EP monochromatic images and iodine-based material decomposition images, respectively. A series of histogram parameters, including the mean, standard error, median, mode, standard deviation, variance, kurtosis, skewness, coefficient of variance, minimum, maximum, entropy, energy, 10th, 25th, 50th, 75th, and 90th percentiles were calculated and compared between the response (partial response or stable disease) and non-response (progressive disease) groups.

RESULTS

The median, mode, and 50th percentile of CT number at EP, and the mean, median, mode, 10th, 25th, 50th, 75th, and 90th percentiles of iodine concentration at EP in the response group were significantly higher compared with the non-response group (*P = 0.0023-0.036). Among these significant parameters, the mean of iodine concentration demonstrated the greatest area under the receiver-operating-characteristic curve for differentiating the response group from the non-response group (0.796).*

CONCLUSION

The mean of iodine concentration was superior to CT number and could be a potential biomarker for assessing response to chemotherapy in patients with PDAC.

CLINICAL RELEVANCE/APPLICATION

The mean of iodine concentration demonstrated the best parameter for the assessment of response to first-line chemotherapy in patients with pancreatic ductal adenocarcinoma.

SSA07-08 Analysis of Pancreatic Cancer by 3.0T 1H Magnetic Resonance Spectroscopy and Correlation with Tumor Differentiation

Sunday, Nov. 26 11:55AM - 12:05PM Room: E353A

Participants
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Li Wang, Shanghai, China (Abstract Co-Author) Nothing to Disclose
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PURPOSE

To discuss the metabolites of tumors and peritumoral pancreatic duct intraepithelial neoplasia (Pan IN) tissue in pancreatic cancer by 3.0T 1H magnetic resonance spectroscopy (1H MRS) and correlation with tumor differentiation.

METHOD AND MATERIALS

47 patients (17 with poorly differentiated tumors and 30 with moderately differentiated tumors) with pancreatic duct adenocarcinoma confirmed by histopathology. Before operation, respiration-triggered water suppression point-resolved spectroscopy (PRESS) sequence of 1H MRS was used for detection of metabolites in tumors and peritumoral Pan IN tissue. To calculate the ratio of choline-containing metabolites (CCM) peak area to lipid (Lip) peak area (CCM/Lip), cholesterol and the unsaturated parts the olenfinic region of fatty acids (Chol+Unsat) peak area to Lip peak area (Chol+Unsat/Lip), Chol+Unsat peak area to CCM peak area (Chol+Unsat/CCM) in every 1H MRS data. The paired sample t test was used for compare metabolites in tumors and peritumoral Pan IN tissue. The independent sample t test was used for compare metabolites in poorly and moderately differentiated tumors of pancreatic duct adenocarcinoma.

RESULTS

24 patients were measured 1H MRS data of tumors tissue and peritumoral Pan IN tissue at the same time. The ratio of CCM/Lip in tumors (2.66±0.84)×10-1 were higher than peritumoral Pan IN tissue (2.00±0.81)×10-1. The ratio of Chol+Unsat/Lip in tumors (3.24±1.09)×10-1 were higher than peritumoral Pan IN tissue (2.58±0.92)×10-1. There were statistically significant differences (P<0.05). The ratio of Chol+Unsat/CCM had no statistical difference between tumors tissue and peritumoral Pan IN tissue. The ratio of CCM/Lip, Chol+Unsat/Lip, Chol+Unsat/CCM had no statistical difference between poorly and moderately differentiated tumors of pancreatic duct adenocarcinoma.

CONCLUSION

3.0T 1H MRS has a significance to distinguish tumors tissue and peritumoral Pan IN tissue in pancreatic cancer, but no associations with tumor differentiation.

CLINICAL RELEVANCE/APPLICATION

3.0T 1H MRS has a significance to distinguish tumors tissue and peritumoral Pan IN tissue in pancreatic cancer, to provide the basis for early diagnosis of pancreatic cancer.

SSA07-09 Quantitative CT-Derived Texture Analysis: A Novel Imaging Biomarker for Predicting Tumor Aggressiveness in Pancreatic Neuroendocrine Neoplasm (PanNET)

Sunday, Nov. 26 12:05PM - 12:15PM Room: E353A

Awards
Student Travel Stipend Award

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Amir Borhani, MD, Pittsburgh, PA (Abstract Co-Author) Consultant, Guerbet SA; Author, Reed Elsevier

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PURPOSE

Non-invasive biomarkers of PanNET are lacking. We sought to determine if CT-derived tumor textural features correlated with markers of PanNET tumor biology (WHO tumor grade, presence or absence of metastatic lymphadenopathy, and distant metastasis).

METHOD AND MATERIALS

An IRB-approved retrospective study of 63 patients with PanNET who underwent surgical resection between 2002 and 2012 was performed. The late arterial phase of the pre-operative CT was used for image analysis. An ROI was placed on the largest tumor cross section. CT textural features were extracted using commercially available software (TexRAD) which applies a 2-step filtration-histogram approach. Statistical and histogram-shape parameters were extracted before and following the application of different levels of filtration (2, 4, and 6mm). Filtration was used to enhance features of different size objects within the lesion. Grade of tumor (based on mitotic rate and Ki-67 index per 2010 WHO classification) and the presence or absence of metastatic lymphadenopathy/distant metastasis were recorded. Correlation between textural parameters, WHO grade, and the presence of nodal/distant metastasis was assessed using Pearson and Kruskal-Wallis tests, respectively. Area under curve (AUC) for ROC

curves was calculated. A p level of <0.05 was considered statistically significant.

RESULTS

A statistically significant correlation was shown between skewness and kurtosis (of both unfiltered and differing level filtered images) and WHO tumor grade (r=0.43 & 0.39, respectively; p<0.005). There was a statistically significant difference in kurtosis and entropy -at different filtration levels- between patients with and without metastases (p=0.019 & 0.003, respectively). Entropy -at 6mm filtration- was also statistically different between patients with and without metastatic nodes (p=0.029). Entropy had a slightly better AUC compared to WHO grade for prediction of metastases and lymphadenopathy (0.74 vs 0.69 & 0.67 vs 0.65, respectively).

CONCLUSION

Quantitative parameters of tumor heterogeneity (kurtosis, skewness, and entropy) show statistically significant correlation with PanNET grade. Tumor entropy is significantly different in PanNET patients with and without nodal/distant metastasis.

CLINICAL RELEVANCE/APPLICATION

PanNET tumor heterogeneity can be used as a potential imaging biomarker for assessment of tumor biology and aggressiveness.

SSA08

Science Session with Keynote: Gastrointestinal (HCC Screening and LIRADS)

Sunday, Nov. 26 10:45AM - 12:15PM Room: E450A

GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Claude B. Sirlin, MD, San Diego, CA (*Moderator*) Research Grant, General Electric Company; Research Grant, Siemens AG; Research Grant, Bayer AG; Research Grant, Arterys Inc; Research Grant, Koninklijke Philips NV; Consultant, Alexion Pharmaceuticals, Inc; Consultant, AstraZeneca PLC; Consultant, BioClinica, Inc; Consultant, Bristol-Myers Squibb Company; Consultant, Bracco Group; Consultant, Celgene Corporation; Consultant, FibroGen, Inc; Consultant, Galmed Pharmaceuticals Ltd; Consultant, F. Hoffmann-La Roche Ltd; Consultant, sanofi-aventis Group; Consultant, Gilead Sciences, Inc; Consultant, ICON plc; Consultant, Intercept Pharmaceuticals, Inc; Consultant, Ionis Pharmacueticals, Inc; Consultant, Johnson & Johnson; Consultant, NuSirt Biopharma, Inc; Consultant, Perspectum Diagnostics Ltd; Consultant, Pfizer Inc; Consultant, Profil Institut fur Stoffwechselforschung GmbH; Consultant, Shire plc; Consultant, Tobira Therapeutics, Inc; Consultant, Takeda Pharmaceutical Company Limited; Consultant, Virtual Scopics; ;
Mustafa R. Bashir, MD, Cary, NC (*Moderator*) Research support, Siemens AG; Research support, General Electric Company; Research support, NGM Biopharmaceuticals, Inc; Research support, TaiwanJ Pharmaceuticals Co, Ltd; Research support, Madrigal Pharmaceuticals, Inc; Consultant, RadMD

Sub-Events

SSA08-01 Gastrointestinal Keynote Speaker: LIRADS Update

Sunday, Nov. 26 10:45AM - 10:55AM Room: E450A

Participants
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SSA08-02 Liver Imaging Reporting and Data System (LI-RADS) v2014: Diagnostic Value of Ancillary Features on MR Imaging

Sunday, Nov. 26 10:55AM - 11:05AM Room: E450A

Awards
Student Travel Stipend Award

Participants
Hersh Sagreiya, MD, Palo Alto, CA (*Presenter*) Nothing to Disclose
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PURPOSE

To determine how the inclusion of ancillary features in the evaluation of liver MR imaging changes the assessment of risk for hepatocellular carcinoma (HCC) per LI-RADS v2014.

METHOD AND MATERIALS

This is an IRB-approved, HIPAA-compliant retrospective study. 32 consecutive cirrhotic patients undergoing Gd-EOB-DTPA enhanced MR imaging of the liver in a 6-month period and with at least one hepatic observation confirmed as benign or malignant were included in the study. Among these patients, a total of 49 lesions were analyzed, including 17 pathologically-proven HCCs and 34 benign lesions. Benignity was confirmed by proving long term (i.e. > 2 year) stability or disappearance at imaging follow-up. Two readers reviewed the images independently, and for each lesion they assessed LI-RADS category (LR) using i) only major criteria and ii) major and ancillary criteria. Any disagreement was resolved in consensus for statistical analysis. Concordant cases included the malignant lesions categorized as LR4 or 5 and the benign lesions categorized as LR1 or LR2. Discordant cases included the malignant lesions categorized as LR1 or 2 and the benign lesions categorized as LR4 or 5. LR3 lesions were considered

indeterminate. The chi-square test was used to determine the difference in LR3 cases between session 1 and 2. Regression analysis was performed to assess the contribution of each ancillary feature to the final LR category.

RESULTS

The inclusion of ancillary features led to a significantly higher number of concordant cases (35 vs. 20; 71% vs 41%) and lower number of indeterminate cases (10 vs. 25; 20% vs. 51%) (P=0.0052). The number of discordant cases was small and unchanged (4 vs. 4; 8%). Regression analysis, after Bonferroni correction for multiple comparisons, showed that changes in the final LR score were significantly associated with the ancillary features "hypointensity on hepatobiliary phase" (P = 0.0021) and "diameter stability >= 2 years" (P = 0.00045).

CONCLUSION

The analysis of the ancillary features included in LI-RADS v2014 results in a lower number of indeterminate cases for the assessment of risk for HCC.

CLINICAL RELEVANCE/APPLICATION

Although the analysis of LI-RADS ancillary features requires additional time, their inclusion is of key value in indeterminate cases (LR3) for determination of malignity or benignity.

SSA08-03 Imaging Outcomes of LI-RADS v2014 Category 2, 3, and 4 Observations on CT and MRI

Sunday, Nov. 26 11:05AM - 11:15AM Room: E450A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The Liver Imaging and Reporting Data System (LI-RADS) was developed to standardize the categorization and reporting of imaging observations in patients at high-risk for hepatocellular carcinoma. However, there have been relatively few studies studying the outcomes of these categories. The purpose of this study is to determine the proportion of LR-2, LR-3, and LR-4 observations that progressed, remained stable, or were downgraded at follow-up.

METHOD AND MATERIALS

This is a retrospective analysis of all clinical CT and MRI exams at our institution since 2013 reported with LI-RADS. CT was performed with 64- and 320-detector row scanners, and MRI was performed at 1.5T and 3T. Pre-contrast, late hepatic arterial, portal venous, and delayed phases were acquired. MRI included 3D fat-suppressed dynamic T1W, single-shot T2W, in- and out-of-phase, and diffusion imaging. Hepatobiliary phase was also acquired if gadoxetate disodium was used. Observation identifiers and LI-RADS categories were extracted from clinical reports. Only untreated observations that had at least one follow-up exam were included in the analysis.

RESULTS

2374 exams were reviewed. 515 category transitions in 288 observations from 171 patients (126 male, 45 female) and 515 scans (135 CT, 380 MRI) were included in the analysis. The mean age was 62 ± 10 years, and the mean follow-up interval was 158 ± 123 days (range: 8 - 779). Of 80 index LR-2 observations, 4 (5%) were downgraded to LR-1, 66 (83%) remained LR-2, and 10 (12%) progressed to LR-3 (n=5), LR-4 (n=4), or LR-M (n=1); 4 progressed to LR-4 (n=3) or LR-M (n=1) within 180 days. Of 242 index LR-3 observations, 26 (11%) were downgraded to LR-1 or LR-2, 174 (72%) remained LR-3, and 42 (17%) progressed to LR-4 (n=29), LR-5 (n=12), or LR-M (n=1); 28 (12%) progressed within 180 days. Of 193 index LR-4 observations, 36 (19%) were downgraded, 119 (62%) remained LR-4, and 38 (20%) progressed to LR-5 (n=36) or LR-M (n=2); 32 (17%) progressed within 180 days.

CONCLUSION

Only 5% of LR-2 observations progressed to LR-4 or higher within 180 days. However, LR-3 and LR-4 observations have higher potential for malignancy and should receive close attention on follow-up.

CLINICAL RELEVANCE/APPLICATION

This study provides further validation for the use of LI-RADS and its criteria. Although the majority of observations remained stable

This study provides further validation for the use of LI-RADS and its effects. Although the majority of observations remained stable on follow-up imaging, the imaging outcomes of LR-2, LR-3, and LR-4 observations differ substantially.

SSA08-04 Intraindividual Comparison between CT and Gadoxetate-Enhanced MRI in the Diagnosis of Hepatic Malignancy Using the LI-RADS: Multi-Center, Multi-Reader Retrospective Study

Sunday, Nov. 26 11:15AM - 11:25AM Room: E450A

Participants
Chansik An, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
Sieun Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Jin-Young Choi, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Myeong-Jin Kim, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To compare the performance of computed tomography (CT) and magnetic resonance imaging (MRI) in the diagnosis of hepatic malignancy using the Liver Imaging Reporting and Data System (LI-RADS).

METHOD AND MATERIALS

Institutional review board approved this retrospective study, and the requirement for patient consent was waived. Our subjects were 234 histologically confirmed hepatic lesions (114 hepatocellular carcinomas [HCCs], 58 non-HCC malignancies, and 59 benign lesions) in 207 patients with chronic liver disease who underwent both gadoxetate-enhanced MRI and CT for suspected hepatic malignancy at 5 academic tertiary hospitals. Four abdominal radiologists first reviewed MRI data, and then CT data 4 weeks later, independently. They determined the presence or absence of the major and ancillary imaging features and performed LI-RADS categorization for each hepatic lesion. Diagnostic performance was calculated and compared using generalized estimating equations, with LR-5/5V/M considered positive for diagnosis of hepatic malignancy (HCC and other malignancies), and with LR-M considered positive for diagnosis of other malignancies.

RESULTS

In all reviewers, compared to CT, MRI showed higher sensitivity and accuracy with comparable specificity, in distinguishing hepatic malignancies from benign lesions; the pooled sensitivities, specificities, and accuracies of CT vs. MRI were 58.4% (402/688) vs. 72.4% (498/688) (P = .013), 83.5% (197/236) vs. 83.9% (198/236) (P = .257), and 64.8% (599/924) vs. 75.3% (696/924) (P = .032), respectively. However, the diagnostic performance did not differ significantly between CT and MRI in the diagnosis of non-HCC malignancies; the pooled sensitivities, specificities, and accuracies of CT vs. MRI were 50.0% (116/232) vs. 57.8% (134/232) (P = .676), 93.5% (647/692) vs. 94.5% (654/692) (P = .385), and 82.6% (763/924) vs. 85.3% (788/924) (P = .185), respectively.

CONCLUSION

Gadoxetate-enhanced MRI may be more accurate than CT in differentiating between malignant and benign hepatic lesions using the LI-RADS, but not between HCC and other malignancies.

CLINICAL RELEVANCE/APPLICATION

In the diagnosis of focal hepatic lesions using the LI-RADS algorithm in patients with chronic liver disease, more appropriate imaging modality can be used, leading to better patient management.

SSA08-05 Frequency/Prevalence of LIRADS Major and Ancillary findings on MRI in Explant Proven Hepatocellular Carcinoma

Sunday, Nov. 26 11:25AM - 11:35AM Room: E450A

Participants
Evan Johnson, MD, New York, NY (*Presenter*) Nothing to Disclose
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Cristina H. Hajdu, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the frequency/prevalence of LIRADS (v2014) major and ancillary findings on MRI in pathologically proven HCCs on explants. To assess inter-observer variability in LIRADS major and ancillary findings, and final LIRADS category.

METHOD AND MATERIALS

122 explant proven HCCs were identified in 103 patients with contrast enhanced MRI prior to explant. Two abdominal imagers reviewed each MRI and evaluated for specific LIRADS features.

RESULTS

Average lesion was 2.4 cm (0.9 to 6 cm). Lesions were rated as LIRADS 5 (reader 1, 54.1%; reader 2, 57.4%), LIRADS 4 (29.5%; 32%), and LIRADS 3 (16.4%; 10.7%). The prevalence of LIRADS major features was: arterial phase hyperenhancement (93.4%; 92.6%), portal venous phase washout (64.8%), delayed phase washout (74.6%; 73%), pseudocapsule (49.2%; 59.8%). Prevalence of LIRADS ancillary findings was: moderately increased T2 signal (88.5%), diffusion restriction (46.7%), mosaic appearance (31.1% and 27%), corona enhancement (23%; 13.9%), intralesional fat (15.6%), increased T1 signal (13.9%), nodule in a nodule appearance (8.2%; 9%), biliary dilatation (0.8%; 0.8%) and liver retraction (0.8%; 0%). Interobserver variability analysis demonstrated perfect agreement (Cohen's kappa 1.0) in presence or absence of portal venous washout, increased T2 signal, increased T1 signal, intralesional fat, diffusion signal, and biliary dilatation. Near perfect agreement was seen in arterial phase enhancement (0.88; 95% CI 0.716-1), delayed washout (0.917; 0.838-0.997), nodule in a nodule appearance (0.9; 0.763-1), and mosaic architecture (0.812; 0.701-0.924). There was substantial interobserver agreement in presence or absence of an enhancing pseudocapsule (0.612; 0.478-0.746), and moderate agreement in corona enhancement (0.502; 0.322-0.683). There was near

perfect agreement in final LI-RADS category (0.816; 0.728 to 0.904).

CONCLUSION

Arterial hyperenhancement and delayed washout were the most common LIRADS major findings in HCC. Aside from moderate T2 high signal, LIRADS ancillary findings were infrequently observed. Up to 45% of HCCs were classified as LIRADS 3/4 lesions (not meeting current OPTN criteria) with near perfect interobserver agreement.

CLINICAL RELEVANCE/APPLICATION

Majority of LIRADS features demonstrate excellent interobserver agreement with most differing opinions in presence or absence of pseudocapsule and corona enhancement.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Krishna Prasad Shanbhogue, MD - 2012 Honored EducatorKrishna Prasad Shanbhogue, MD - 2013 Honored Educator

SSA08-06 A Comparative Study of Computer-aided Diagnosis and Radiologists: LI-RADS-Based Assessment of Hepatocellular Carcinoma

Sunday, Nov. 26 11:35AM - 11:45AM Room: E450A

Participants
Qingqing Chen, Hangzhou, China (*Presenter*) Nothing to Disclose
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Hongjie Hu, MD, Hangzhou, China (*Abstract Co-Author*) Nothing to Disclose
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Yen-Wei Chen, Kusatsu, Japan (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To quantify the major features of LI-RADS and develop a computer-aided diagnosis (CAD) system for hepatocellular carcinoma (HCC), and to evaluate the performance of our CAD system by comparing computerized assessment with radiologists' reviews.

METHOD AND MATERIALS

In this retrospective study, 65 consecutive patients in high risk of HCC were reviewed, all patients had pathologically confirmed HCC observations and underwent CT scan from January 2015 to January 2017. Two blinded radiologists assessed the major features (diameter, arterial phase hyperenhancement (APHE), washout, capsule) and assigned LI-RADS categories in consensus. For the computer-aided diagnosis(CAD), the tumors and normal liver tissue were first segmented at the maximum slice at 2-phase CT using a random-walk based interactive segmentation algorithm. Then the computer algorithm was employed to quantify the LI-RADS major features and the tumors were graded into LR3, 4, 5 based on the extracted features. Inter-reader agreement was calculated using Cohen's kappa, the accuracy of the LI-RADS categorization was compared between the radiologist and our CAD system.

RESULTS

The study included 60 males and 5 females, with a mean age of 57±11.9 years) and the mean diameter of 65 observations was 45.3±27.8mm. Inter-reader agreement in major features between two radiologists was APHE (k=0.862), washout (k=0.877), capsule (k=0.785) and LR category (k=0.8). The consistency of CAD and radiologists in features detection was APHE(k=0.908), washout(k=0.908), capsule(k=0.754) and LR categorization (k=0.738). Based on the pathology, the diagnostic accuracy of CAD and radiologists was 93.8% vs 92.3%, respectively, by assuming both LR4(probably HCC) and LR5 (definite HCC) are positive. The diagnostic accuracy of CAD and radiologists was 76.9% and 64.6%, respectively, if only LR5 is positive.

CONCLUSION

Our study identified and quantified effective major features from LI-RADS and developed a computer-aided diagnosis (CAD) system for identifying HCC major features and corresponding final categorization. All three major features extracted by CAD were in good agreement with radiologists and the diagnostic accuracy of CAD in LI-RADS categorization was even higher than radiologists.

CLINICAL RELEVANCE/APPLICATION

With the involvement of computer algorithms and features quantification of LI-RADS, CAD can obtain high stability and diagnosis efficiency in HCC screening.

SSA08-07 Validation of The Liver Imaging Reporting and Data System with Gadoxetic acid-enhanced MR Imaging in a Prospective Surveillance Study: Evaluation of LI-RADS Category 4 and 5 Criteria

Sunday, Nov. 26 11:45AM - 11:55AM Room: E450A

Participants
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Seong Ho Park, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Research Grant, DONGKOOK Pharmaceutical Co, Ltd; Research Grant, Central Medical Service Co, Ltd

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PURPOSE

To validate the Liver Imaging Reporting and Data System (LI-RADS) v2014 category 4 (LR-4) and 5 (LR-5) criteria on gadoxetic acid-enhanced magnetic resonance imaging (MRI) in a surveillance setting for patients with cirrhosis at high risk of hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

A prospective surveillance study recruited 407 cirrhosis patients having an estimated annual risk of HCC >5% who underwent one to three, biannual screening gadoxetic acid-enhanced MRI examinations between November 2011 and August 2014. The nodules detected on MRI were categorized according to the the LI-RADS v2014. The final diagnosis was based on the results of a histologic examination and/or follow-up image studies. The diagnostic performance of LR-5 and >=LR-4 criteria in diagnosing HCC was described and compared by per-lesion sensitivity and per-examination specificity with 95% confidence intervals (CI).

RESULTS

During the 1100 sessions of MRI, the 43 sessions detected 48 HCCs. The 13 LR-5 lesions included 12 HCCs and one inflammatory pseudotumor. The 53 LR-4 nodules were confirmed as HCC in 30, considered as presumed dysplastic nodules in five, AP shunt or small hemangioma in four, inflammatory lesions in 13 and abscess in one. The per-lesion sensitivity of LR-5 and >=LR-4 was 25 (12/48) % (95% CI, 13.6, 39.6%) and 87.5 (42/48) % (74.8, 95.3%), respectively (P<0.001). The per-examination specificity was 99.9 (1056/1057) % (99.5, 100%) and 98.5% (1041/1057) (97.6, 99.1%), respectively (P<0.001).

CONCLUSION

In cirrhotic patients at high risk of HCC, the combination of LR4 and LR-5 categories improved the per-lesion sensitivity to detect HCC with a mild compromise in the per-examination specificity.

CLINICAL RELEVANCE/APPLICATION

Our study results prospectively validate the Liver Imaging Reporting and Data System v2014 category 4 and 5 criteria on gadoxetic acid-enhanced MRI in a surveillance setting for patients with cirrhosis at high risk of HCC.

SSA08-08 CEUS LI-RADS for Interpreting Observations in Patients at Risk for HCC: A Validation Study

Sunday, Nov. 26 11:55AM - 12:05PM Room: E450A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The purpose of this study is to validate the CEUS LI-RADS algorithm and determine its ability to diagnose HCC and discriminate between HCC, other malignant/pre-malignant lesions and benign liver entities. Of particular interest is the specificity of LR-5.

METHOD AND MATERIALS

229 liver lesions from a single centre assessed with CEUS were retrospectively included in a blind read (LR-5,124; LR-5V,11; LR-M,31; LR-4,12; LR-3,31; LR-2,2; LR-1,18). It comprised a single AVI file showing arrival of contrast to peak enhancement, and still grayscale, arterial and portal venous/late phase CEUS images. Three expert radiologists from two centres conducted the read using CEUS LI-RADS v2016. Readers responded on arterial, portal-venous/late phase enhancement characteristics, presence of thrombus, and timing and intensity of washout. A LI-RADS category was assigned for each case. Pathology was available for 145 cases (HCC(123), Mixed HCC/CholangioCa(1), CholangioCa(7), Metastasis(8), PEComa(1), Lymphoma(1), Benign Nodule(3)). Clinical and imaging (CT/MR) correlation was additionally used, as available.

RESULTS

Pathology proven malignancy had very strong results on CEUS. LR-5 specificity is 94%. Sensitivity and positive predictive value are 95% and 93% respectively. Youden's Index is 89%. For LR-5V and LR-M, sensitivity, specificity and positive predictive values are 100%, 100% and 87% and 79%, 97% and 88% respectively. Similar strong values are obtained for LR-1 and LR-3 (93%, 99% and 96% and 83%, 97% and 87% respectively). LR-4 category, including several different patterns suspicious for HCC, performed well with regards to specificity (98%), but less well for sensitivity and PPV (both 64%). In a blind read format, criteria for LR-4 are most challenging to interpret. LR-2 category performed least well, possibly related to its inclusion criteria of very small nodules, resulting

in a small sample entry. For inter-rater reliability, kappa value was 0.86.

CONCLUSION

CEUS LI-RADS algorithm is an excellent tool for identifying malignant and clearly benign lesions. Best performance is for HCC and non-hepatocellular malignancy.

CLINICAL RELEVANCE/APPLICATION

CEUS LI-RADS allows confident non-invasive diagnosis of HCC and other non-hepatocellular malignancies. Use of the CEUS algorithm standardizes interpretation and management of nodules in at risk patients.

SSA08-09 Using Deep Learning to Investigate the Value of 'Washin and Washout' in Hepatocellular Carcinoma for Malignancy Characterization

Sunday, Nov. 26 12:05PM - 12:15PM Room: E450A

Participants
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Hairong Zheng, Shenzhen, China (*Abstract Co-Author*) Nothing to Disclose
Lijuan Zhang, MD, Shenzhen, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The purpose of this study was to investigate the potential value of 'washin and washout' in HCC for malignancy characterization using deep learning.

METHOD AND MATERIALS

Forty-six consecutive patients with 46 hisotologically proven HCCs from September 2011 to October 2015 were included for this retrospective study. Gd-DTPA-enhanced MR imaging were performed with a 3.0T MR scanner, consisting of pre-contrast, arterial, portal venous, and delayed phase images. The histology grading of HCCs was retrieved from the archived clinical histology report, including twenty-one low grade and twenty-five high grade HCCs. The process of "washin" in HCC corresponds to pre-contrast and arterial images, while "washout" corresponds to arterial and portal venous images. Firstly, a resampling method was performed to extract multiple 2D orthogonal planes in 3D volumes of HCCs in each phase to increase the dataset for training. Then, deep features of HCCs in pre-contrast, arterial and portal venous phase were extracted for malignancy characterization, respectively. Finally, fusion of deep features derived from pre-contrast, arterial or portal venous phase was conducted using multi-kernel support vector machine for malignancy characterization. Values of characterization performance were denoted as mean±standard deviation as a result of 4-folded cross-validation with 10 repetitions on the data set.

RESULTS

Deep feature derived from arterial phase (0.9154±0.0726) yielded best accuracy, followed by portal venous phase (0.8615±0.0754) and pre-contrast (0.7769±0.0639). In terms of multimodal fusion, the accuracy of Arterial & Portal venous ("washout") (0.9198 ± 0.0754) was similar to that of the Arterial(0.9154 ± 0.0726), while fusion of deep features in Pre-contrast & Arterial ("washin") yielded better result (0.9462 ± 0.0493) when two modalities were fused. Finally, fusion of deep features in three phases ("washin and washout") yielded best accuracy (0.9538 ± 0.0510) for malignancy characterization.

CONCLUSION

This study demonstrates that deep feature of "washin and washout" in HCCs has excellent performance for malignancy characterization.

CLINICAL RELEVANCE/APPLICATION

Deep feature is automatically learned from the images of "washin and washout" in HCCs, which may be significant to formulate gold standard for lesion characterization in clinical practice, rather than depending on radiologist interpretation or quantitation of intensity changes in the process of "washin and washout" .

SSA09

Gastrointestinal (Dual/Multi Energy CT)

Sunday, Nov. 26 10:45AM - 12:15PM Room: E450B

BQ CT GI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

Benjamin M. Yeh, MD, San Francisco, CA (*Moderator*) Research Grant, General Electric Company; Author with royalties, Oxford University Press; Shareholder, Nextrast, Inc; Research Grant, Koninklijike Philips NV; ;
Daniele Marin, MD, Durham, NC (*Moderator*) Research support, Siemens AG
Lakshmi Ananthakrishnan, MD, Dallas, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSA09-01 Iodine Concentration Images in Dual-Energy CT: Improved Visualization of Washout Characteristics in Hepatocellular Carcinoma

Sunday, Nov. 26 10:45AM - 10:55AM Room: E450B

Participants
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Manuel Patino, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine the diagnostic potential of Material Density (MD) Iodine images in dual-energy CT (DECT) for visualization and quantification of the washout phenomenon in hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

The study complied with HIPAA guidelines and was approved by the ethics committee of the institutional review board. Thirty-one patients with known or suspected HCC were included. All of them underwent both single-source DECT and MRI within less than three months. Portal venous phase CT imaging was performed with dual energies of 140 and 80 kVp, and monoenergetic (Mono-E) images (at 65 keV) and MD iodine images were calculated. We determined the lesion-to-liver ratio (LLR) and the contrast-to-noise ratio (CNR) for HCC. All parameters were assessed in mono-energetic 65 keV images, MD-iodine images, and MRI. Paired t test was used to compare LLR, CNR, and ap-LLR in Mono-E, MD-iodine, and MR images.

RESULTS

The CNR was significantly higher in the MD-iodine images (0.74 ± 0.36), compared to the Mono-E (0.01 ± 0.01) and MR images (0.02 ± 0.02). Washout was represented by low LLR values, which was most obvious observed in the MD-iodine images (0.75 ± 0.13), compared to the Mono-E (0.85 ± 0.12) and MR images (0.87 ± 0.12).

CONCLUSION

MD-iodine images in DECT improve the visualization of the washout phenomenon in HCC and allows for quantitative measurements.

CLINICAL RELEVANCE/APPLICATION

Washout phenomenon is a diagnostic imaging marker of HCC, which is significantly better visible in MD iodine images. In addition, quantitative iodine assessment of washout makes examinations comparable, even if patients were not examined at the identical scanner installation each time.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Dushyant V. Sahani, MD - 2012 Honored EducatorDushyant V. Sahani, MD - 2015 Honored EducatorDushyant V. Sahani, MD - 2016 Honored EducatorDushyant V. Sahani, MD - 2017 Honored Educator

SSA09-02 Value of Single Source Dual Energy CT Based Unenhanced Cystic Component in Differential Diagnosis of Liver Abscess and Liver Metastases

Sunday, Nov. 26 10:55AM - 11:05AM Room: E450B

Participants
Nan Wang, Dalian, China (*Presenter*) Nothing to Disclose
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PURPOSE

To investigate value of ssDECT based unenhanced cystic component in differential diagnosis of liver abscess and liver metastases.

METHOD AND MATERIALS

From September 2011 to Dec 2016, 58 patients with 79 liver lesions(29 liver abscess by percutaneous drainage or combining with clinical symptom and imaging after follow-up, and 50 liver metastases by imaging, medical history and follow-up) underwent ssDECT with GSI. All lesions have obvious liquefaction necrosis area. The mean CT of value of monochromatic (40-140)keV, fat (water) and blood (water) concentration for the lesions and effective atomic number(eff-Z) were measured by a senior medical doctor and an observer on an AW 4.5 workstation. The two measurement data have good consistency(ICC>0.75). the data of the senior medical doctor was selected to use Mann-Whitney rank sum test. The slope of spectral curve(K) was measured and divide into 3 types: decrement curve(K<-0.1), straight curve(-0.1<=K<=0.1) and increment curve(K>0.1). ROC curves were then constructed to evaluate the effectiveness of each parameter.

RESULTS

The range of single-energy CT values of liver metastases [from (20.09±7.48)HU to (31.04±15.29)HU] was significantly higher than that of liver abscesses [from (17.79±8.17)HU to (20.54±13.28)HU] at energy levels ranging from 40 to 110 keV(P<0.05). When CT value at 40 keV greater than 30.49 HU, the specificity and sensitivity of liver metastases except liver abscess were 82.8% and 56% (AUC=0.701). The median blood-water concentration of liver metastases was 523.85mg/cm3, significantly higher than that of liver abscesses (352.86mg/cm3, P<0.05). The median fat-water concentration of liver abscesses was -84.89mg/cm3, significantly higher than that of liver metastases (-124.64mg/cm3,P<0.05). The eff-Z of liver metastases(7.66±0.16)was significantly higher than that of liver abscesses (7.58±0.14, P<0.05). In the 29 liver abscesses, there are 14(48.3%) straight curves , while in the 50 liver metastases, there were 27(54%) descending curves.

CONCLUSION

Spectral CT-based unenhanced cystic component is an effective methods in differential diagnosis of liver abscess and liver metastases.

CLINICAL RELEVANCE/APPLICATION

ssDECT provide more information for clinical diagnosis by plain scan.

SSA09-03 Enhanced Demarcation of Hepatic Metastases from Colorectal Cancer Using Noise-Optimized Virtual Monoenergetic Reconstructions from Dual-energy Computed Tomography of the Liver

Sunday, Nov. 26 11:05AM - 11:15AM Room: E450B

Participants
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PURPOSE

The aim of this study was to evaluate the impact of noise-optimized virtual monoenergetic imaging (VMI+) reconstructions on quantitative and qualitative image parameters in patients with hepatic metastases from colorectal cancer at abdominal dual-energy computed tomography (DECT).

METHOD AND MATERIALS

Forty-two patients (29 men; 67.1±12.3 years) with histopathologically confirmed hepatic metastases from colorectal cancer underwent triphasic contrast-enhanced DECT of the abdomen. Images from the portal venous phase were post-processed with the standard linear blending technique (M_0.6) as well as with the traditional virtual monoenergetic (VMI) and noise-optimized VMI+ algorithms in 10-keV intervals from 40 to 100 keV. Attenuation measurements were performed in hepatic lesions, unaffected liver tissue, rectus abdominis muscle, and adjacent visceral fat to calculate objective signal-to-noise (SNR) and contrast-to-noise (CNR) ratios. Five-point scales were used to evaluate overall image quality and lesion delineation by three blinded radiologists with varying levels of experience.

RESULTS

Objective indices SNR and CNR (negative values indicating best contrast of hypoattenuating lesions) of liver metastases were best in 50-keV VMI+ series (3.5±2.1 and -3.6±2.0), significantly superior to all other reconstructions (all *P*<0.001; SNR M_0.6: 2.4±1.5; CNR M_0.6: -2.6±1.8). Qualitative image parameters showed highest values for 50-keV VMI+ reconstructions (median 5, respectively; *P*<=0.023) regarding overall image quality. Qualitative assessment of lesion delineation peaked in 40-keV VMI+ (median 5) and 50-keV VMI+ (median 4; *P*=0.067), significantly superior to all other reconstructions (all *P*<0.001; M_0.6: median 3).

CONCLUSION

Noise-optimized VMI+ reconstructions at 50 keV can substantially increase quantitative image quality and improve subjective assessment of overall image quality and lesion delineation of hepatic metastases from colorectal cancer compared to standard image reconstruction and traditional VMI.

CLINICAL RELEVANCE/APPLICATION

Detection of hepatic metastases from colorectal cancer could be improved using noise-optimized VMI+ post-processing in patients undergoing contrast-enhanced DECT of the liver.

SSA09-04 Dual-Energy Spectral CT: Improving Preoperative Diagnostic Accuracy of Regional Lymph Node Metastasis in Colorectal Cancer

Sunday, Nov. 26 11:15AM - 11:25AM Room: E450B

Participants
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PURPOSE

To investigate the performance of Dual-Energy Spectral CT (DEsCT) in preoperative diagnosis of regional metastatic lymph nodes(LNs) in patients with colorectal cancer (CRC).

CONCLUSION

The preoperative diagnostic accuracy of lymph node metastasis in patients with CRC can be significantly improved by using quantitative parameters derived from DEsCT.

CLINICAL RELEVANCE/APPLICATION

The quantitative parameters derived from DEsCT can be used to improve preoperative identification of lymph node metastasis in patients with CRC.

SSA09-05 Iodine Quantification on Spectral Detector-based Dual-energy CT Enterography: Correlation with Crohn's Disease Activity Index

Sunday, Nov. 26 11:25AM - 11:35AM Room: E450B

Participants
Yeon Soo Kim, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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PURPOSE

To correlate CT parameters including iodine concentration on spectral detector-based dual-energy CT enterography (DE CTE) with Crohn's disease activity index (CDAI).

METHOD AND MATERIALS

From June 2016 to May 2017, 39 patients with known CD were retrospectively enrolled. Two radiologists reviewed spectral detector-based DE CTE images in consensus for the location and number of involved bowel, wall thickness, enhancement pattern, subjective degree of enhancement, degree of mesenteric fat infiltration, comb sign, lymphadenopathy, fistula, and obstruction, and the presence of mesenteric abscess or gallstone. For the quantitative analysis, HU and iodine concentration (mg•I/ml) for the diseased bowel with the strongest enhancement were measured on conventional polychromatic image and iodine quantification map, respectively. Pearson's correlation test and multiple linear regression analysis assessed the correlation between CT parameters and CDAI.

RESULTS

Significant correlations were found between CDAI and several CT parameters such as number of lesions (correlation coefficient=0.573), bowel wall thickness (0.477), pattern of bowel wall enhancement (0.428), subjective degree of enhancement (0.656), mesenteric fat infiltration (0.567), comb sign (0.664), and fistula (0.425) (P<0.05). In addition, there were significant correlations between CDAI and other quantitative CT parameters such as iodine concentration (correlation coefficient=0.744) and relative degree of enhancement (correlation coefficient=0.541) (P<0.001). However, only iodine concentration measured on iodine map remained an independent variable associated with CDAI after adjustment for other confounders in multivariate analysis

(P=0.001). The linear regression equation for CDAI (Y) and iodine concentration (X) was Y = 53.549X + 55.111 with R2=0.726.

CONCLUSION

Iodine concentration measured on spectral detector-based DE CTE represents an easy and convenient biomarker to monitor the disease activity of CD.

CLINICAL RELEVANCE/APPLICATION

Crohn's disease activity can be quantified and monitored by iodine concentration measured on the diseased bowel using spectral detector-based dual-energy CT enterography.

SSA09-06 Feasibility of Using Monochromatic Imaging and Adaptive Statistical Iterative Reconstruction (ASIR) Combined With GSI Assist for Individually Reducing Radiation and Iodine Contrast Dose in Computed Tomographic Enterography

Sunday, Nov. 26 11:35AM - 11:45AM Room: E450B

Participants
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Yu Zhang, MS, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To investigate the image quality and feasibility of using monochromatic imaging and ASIR combined with GSI Assist for individually reducing radiation and iodine contrast dose in CT enterography.

METHOD AND MATERIALS

101 patients (68M, 33F, age 18-78 years ,BMI 18.59-28.73) with proven or suspected small intestinal disease were randomly divided into four groups: group A (n=27) and group B (n=20) were scanned with 120 kVp polychromatic imaging using noise index (NI) of 10 with FBP reconstruction; group C (n=25) and group D (n=29) were scanned by using GSI Assist using NI of 10 (group C) and 13 (group D). And contrast medium protocol were 450mgI/kg for group A, and 300mgI/kg for group B, C, D. Regions of interests were drawn in distance ileum wall and nearby intestinal lumen, optimal keV were generated by GSI viewer automaticly. GSI groups were reconstructed at optimal keV with 50%ASIR. Quantitative parameters (CT values, standard deviation (SD) of portal vein, paraspinal muscle and fat, SNR, CNR) were measured and image quality were qualitatively assessed.

RESULTS

The range of the optimal keV of the group C and D were 57-64keV. The CT values in group A, C and D was found no significant difference, but higher than that in group B; Image noise in group A and B showed no significant difference, but was higher than that in group D; Image noise in group C was the least; The SNR and CNR in group D were lower than that in group C but higher than group A and B; The subjective image assessment in group A and D provided similar image quality, but lower than that in group C. There were no significant differences among the group A, B and C in CTDIvol and DLP, but dose in group D was significantly lowest. The CTDIvol and DLP were reduced by 34.01% and 34.28% respectively compared with 120kV scans.

CONCLUSION

The use of monochromatic imaging at 60kev and 50%ASIR combined with GSI Assist can individually reduce radiation and iodine dose without decreasing image quality in CT enterography.

CLINICAL RELEVANCE/APPLICATION

It will be great beneficial for patients who often undergo numerous imaging reexaminations to take individualized therapeutic options and monitor the response to therapy. Various parameters of the spectral CT may be helpful in the detection of bleeding, reduction of beam-hardening artifact, inflammation and tumor discrimination, staging or grading and other aspects of the clinical application as the GSI imaging dose reduced.

SSA09-07 In Vivo CT Imaging Performance of a Tantalum-Based Nanoparticle Contrast Agent Compared to Iopromide at Large to Obese Patient Sizes Simulated by Swine in Adipose-Attenuation Plastic Encasements

Sunday, Nov. 26 11:45AM - 11:55AM Room: E450B

Participants
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PURPOSE

To compare the CT imaging performance of a carboxybetaine zwitterionic-coated tantalum oxide (TaCZ) nanoparticle contrast agent against a conventional iodinated agent (iopromide) for vascular and visceral enhancement in large to obese patient sizes simulated by swine in adipose-attenuation plastic encasements.

METHOD AND MATERIALS

In our institutional animal care and use committee-approved study, we imaged 30- to 68-kg swine placed inside three adipose-attenuation plastic rings sized to simulate large, obese, and morbidly obese abdominal girths of 102 cm, 119 cm and 137 cm. Swine were then injected with either IV TaCZ or iopromide at 500 mg element/kg, given over 30 seconds and imaged with scan delays of 29, 39, 60, and 80 seconds on a clinical 64-detector-row CT scanner. Each swine was scanned in a given adipose ring size with each agent in consecutive weeks; two different swine were used for each of the six agent/girth combinations. Two blinded readers independently scored scans for the clarity of specific visceral arteries and veins on a five-point Likert scale using 0 = "not seen" to 4 = "vivid clarity" (individual visceral arteries at all phases, individual visceral veins at 60- and 80-second scan delays). The objective intensity of contrast enhancement was measured by 5 regions of interest placed in the aorta and liver. Findings were compared by paired t-tests and Wilcoxon signed rank tests.

RESULTS

The mean peak enhancement was significantly higher for TaCZ than for iopromide for the aorta (270 versus 199 HU, respectively, $p<0.001$) and in the liver (61.3 versus 45.2 HU, respectively, $p<0.001$). The TaCZ vascular clarity score was higher than iopromide in 59%, 82% and 85% of the individual vessels at the 102 cm, 119 cm and 137 cm sizes respectively ($p<0.01$). TaCZ was scored higher than iopromide in 62% of the arteries and in 89% of the veins ($p<0.01$). None of the vessels showed lower clarity scores with TaCZ than with Iopromide.

CONCLUSION

Tantalum-based contrast material provides higher contrast enhancement compared to equal-dose iopromide in large to obese simulated patient sizes.

CLINICAL RELEVANCE/APPLICATION

Swine/phantom results suggest that tantalum-based contrast material may dramatically improve vascular and visceral contrast enhancement and improve diagnostic utility at CT in large to obese patients.

SSA09-08 Machine Learning Of Dual Energy CT Data from Liver Tumors: Impact on Predictive Value for Ablation Success

Sunday, Nov. 26 11:55AM - 12:05PM Room: E450B

Participants
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PURPOSE

To investigate the potential of machine learning based on texture analysis of dual energy CT (DECT) images for the prediction of local tumor progression (LTP) after RF ablation of focal liver lesions, and to compare its added value with a similar approach based on standard CT images.

METHOD AND MATERIALS

This study comprises a retrospective analysis for 39 patients who received a DECT scan (Discovery HD, GE Healthcare) of the liver, acquired within 24 hours after RF ablation of a liver lesion. For each DECT data set, a mask was generated based on the segmented ablation zone. For each of the obtained monochromatic image series (40keV-140keV) of the DECT scan, texture analysis was performed within the mask by building a GLCO matrix and extracting 12 relevant tissue texture features (of which contrast, energy and entropy). Absence or presence of LTP was registered from follow-up imaging during at least 1 year after ablation. A support vector machine (SVM) algorithm was used to predict LTP from the features for all monochromatic series. Results were compared to the SVM prediction based on the texture statistics of 70keV image series only, which are representative for standard CT image.

RESULTS

The SVM algorithm was trained based on data from 32 patients. The ROC analysis of prediction of LTP of the training set showed a higher area under curve (AUC) when based on the DECT series compared to the standard CT series (0.81 vs. 0.49). For DECT, at optimal cutoff, sensitivity and specificity were respectively 51% and 95%, whereas for the standard CT a sensitivity of 20% and specificity of 86% was observed.

CONCLUSION

Our results suggest that an SVM algorithm applied on texture statistics of DECT data might be more sensitive to residual tumor, yielding a more accurate predictor for LTP, compared to a similar approach based on standard CT data. Additional experiments on testing data and optimization of the used images and texture features are needed to confirm these preliminary findings.

CLINICAL RELEVANCE/APPLICATION

Early finding of residual tumor tissue after RF ablation can help to improve long-term patient outcome.

SSA09-09 Dual-Energy CT for Liver Iron Quantification in Patients with Hematological Disorders

Sunday, Nov. 26 12:05PM - 12:15PM Room: E450B

Participants
Sebastian Werner, Tuebingen, Germany (*Presenter*) Nothing to Disclose
Marius Horger, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the feasibility of virtual iron content (VIC) imaging at dual-energy computed tomography (DECT) for evaluation of the liver iron content (LIC) in patients with hematological disorders using a new examinational technique.

METHOD AND MATERIALS

The local institutional review board gave its approval for the retrospective evaluation of non-contrast CT-image data obtained in hematological patients in the routine diagnosis for exclusion of pulmonary infection during antitumor treatment. All patients received chest-CT which included the upper half of the liver and spleen. Examinational protocol was dual energy (DE, 100 and 140kV), 89 mAs, 0.28 rotation time, pitch 0.7, 64x0.6 acquisition, 1.5mm slice thickness, 1 mm increment, medium smooth Q30f kernel and iterative reconstruction (i3). Image data was post-processed with an automatic algorithm on a prototype. After material decomposition, a liver map was created and a freehand ROI was drawn including most of the examined liver. The mean CT value (HU) was calculated and subsequently the virtual iron content (VIC) expressed in mg/ml. All patients had current serum ferritin values as part of the work-up of their underlying disease. Image data of 70 patients examined between September 2016 and March 2017 could retrospectively be analyzed. Mean time interval between CT and serum ferritin quantification was 1 day (SD, 10d). Patients with normal serum ferritin values who did not receive blood products were considered controls.

RESULTS

32 (27.1%) patients (controls) had no blood transfusions whereas 72.9% had one or more transfusions. Mean serum ferritin value and VIC was 240.7 µg/dl (range, 1.3-2628.0 µg/dl) and 1.34 mg/ml (range, -0.83-7.56 mg/ml) in the post-transfusional group and 74.2 µg/dl (range, 3.0-456.0µg/dl) and 0.7 mg/ml (range, -2.1-3.0) in the control group. Correlation between measured mean iron value and serum ferritin was strong ($\rho = 0.62$) ($p<0.0001$).

CONCLUSION

Calculated hepatic VIC using the new examinational protocol and post-processing prototype strongly correlates with serum ferritin values and could be used in the routine diagnosis for evaluation of post-transfusional hemosiderosis.

CLINICAL RELEVANCE/APPLICATION

Elevated LIC can be damaging in particular in patients exposed to other hepatotoxic drugs (e.g. chemotherapy) and therefore accurate and simple quantification is desirable.

SSA10

Genitourinary (Functional Renal Imaging and Contrast Issues)

Sunday, Nov. 26 10:45AM - 12:15PM Room: E351

CT GU MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Harriet C. Thoeny, MD, Bern, Switzerland (*Moderator*) Advisory Board, Guerbet SA
Zhen J. Wang, MD, Hillsborough, CA (*Moderator*) Stockholder, Nextrast, Inc

Sub-Events

SSA10-01 Intravenous Administration of Iodixanol is Not Associated with Increased Risk of Acute Kidney Injury, Dialysis, or Mortality: A Propensity Score-Adjusted Study

Sunday, Nov. 26 10:45AM - 10:55AM Room: E351

Participants
Jennifer S. McDonald, PhD, Rochester, MN (*Presenter*) Research Grant, General Electric Company
Robert J. McDonald, MD, PhD, Rochester, MN (*Abstract Co-Author*) Consultant, General Electric Company; Investigator, General Electric Company
Eric E. Williamson, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
David F. Kallmes, MD, Rochester, MN (*Abstract Co-Author*) Research support, Terumo Corporation Research support, Medtronic plc Research support, Sequent Medical, Inc Research support, Benvenue Medical, Inc Research support, General Electric Company Consultant, General Electric Company Consultant, Medtronic plcConsultant, Johnson & Johnson

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PURPOSE

To compare the rates of acute kidney injury (AKI), emergent dialysis, and short-term mortality between patients who were intravenously administered the iso-osmolar contrast material (IOCM) iodixanol and patients who underwent a noncontrast Computed Tomography (NCCT) scan.

METHOD AND MATERIALS

Study design and implementation for our study were overseen by our institutional review board and conformed to HIPAA guidelines on patient data integrity. All patients who received an iodixanol-enhanced (IOCM group) or noncontrast (NCCT group) CT scan from January 2003 to December 2014 were identified. Patients were subdivided into CKD Stage I-II (eGFR > 60 ml/min/1.73m2), III (eGFR 30-59 ml/min/1.73m2), and IV-V (eGFR<30 ml/min/1.73m2) subgroups and separately underwent propensity score stratification and matching. Rates of AKI, emergent dialysis, and mortality were compared between IOCM and NCCT groups. Additional analyses incorporating IV fluid administration, including additional CT scans from other sites within our instutition, and a paired analysis of patients that received both IOCM and NCCT scans during the study timeframe were also performed.

RESULTS

A total of 5758 patients (1538 CKD Stage I-II; 2899 CKD Stage III; 1321 CKD Stage IV-V) were included in the study. Following propensity score adjustment, rates of AKI, dialysis, and mortality were not significantly higher in the IOCM group compared to the NCCT group for all CKD subgroups (AKI ORs 0.74-0.91, p=.16-.69; dialysis ORs 0.74-2.00, p=.42-.76, mortality ORs = 0.98-1.24, p=.39-.88). Sensitivity analyses yielded similar results.

CONCLUSION

Among patients at highest perceived risk of PC-AKI, intravenous administration of iodixanol for contrast-enhanced CT was not an independent risk factor for AKI, dialysis, or mortality.

CLINICAL RELEVANCE/APPLICATION

Among patients at highest perceived risk of PC-AKI, intravenous administration of iodixanol for contrast-enhanced CT was not an independent risk factor for AKI, dialysis, or mortality.

SSA10-02 Role of Renal Doppler and Shear Wave Elastography in Diabetic Nephropathy

Sunday, Nov. 26 10:55AM - 11:05AM Room: E351

Awards
Student Travel Stipend Award

Participants
Venkatram Krishnan, MBBS , New Delhi, India (*Presenter*) Nothing to Disclose
Amita Malik, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Currently albuminuria is used for diagnosis of diabetic nephropathy; this has poor sensitivity and specificity, especially in its early stages. A combination of intrarenal resistive index and renal shear modulus, which indirectly measures intrarenal fibrosis, may enable its early diagnosis, as this study attempts to evaluate. There have been virtually no studies on combination of the two in diabetic nephropathy.

METHOD AND MATERIALS

This cross-sectional study consisted of 260 consecutive consenting subjects - 130 cases of diabetic nephropathy (diagnosis confirmed by albuminuria >30 mg/24 hrs with highly sensitive Hemo-One analyzer) and 130 healthy non-diabetic controls, who underwent grey scale ultrasound, renal acoustic radiation force impulse elastography for average shear modulus, and renal doppler for average intrarenal resistive index, of both kidneys. The eGFR for each of the subjects was calculated from the serum creatinine value using modified MDRD formula.

RESULTS

The mean intrarenal resistive index of the cases was found to be higher than that of the controls (0.72 vs 0.62, $p<0.001$). A progressive rise in resistive index was found with each stage of diabetic nephropathy, highest in stage V (mean 0.78). The mean shear modulus of cases, overall and in each stage, was also found to be higher than that of the controls (8.59 vs 4.32 kPa, $p<0.001$). A significant rise in shear modulus was noted in the initial stages, highest in stage II (mean 10.76 kPa). In later stages, a progressive decrease in shear modulus was observed. Maximum accuracy for diagnostic performance of resistive index was at a cut off of 0.65 (sensitivity and specificity of 90% and 76.2% respectively), while that for shear modulus was at 5.31 kPa (90.8% and 84.6%). Combined use of both in parallel gave the highest accuracy (81.7% and 96.3%). Very good interrater agreement was present between resistive index and shear modulus (κ 0.85).

CONCLUSION

A combination of renal doppler and renal shear wave elastography provides an excellent, simple, accurate and noninvasive tool for the early diagnosis as well as assessment of stage of diabetic nephropathy.

CLINICAL RELEVANCE/APPLICATION

Early diagnosis of diabetic nephropathy and adoption of multifactorial interventions with renoprotective agents for its treatment can halt or slow its progression.

SSA10-03 Functional MRI for Quantification of Renal Perfusion Changes After Pharmacological Intervention with an Angiotensin Converting Enzyme Inhibitor

Sunday, Nov. 26 11:05AM - 11:15AM Room: E351

Participants
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PURPOSE

Evaluating the applicability of arterial spin labeling (ASL) and T1 mapping to quantify the effect of pharmacological intervention with the angiotensin converting enzyme (ACE) inhibitor Captopril on kidney perfusion and T1 relaxivity of renal tissue.

METHOD AND MATERIALS

15 healthy adults (22-50 years) were examined with a 1.5T MRI (Siemens Avanto), twice at baseline conditions and 60 minutes after a single oral dose of 50 mg Captopril. The MRI protocol consisted of flow-alternating-inversion-recovery (FAIR) true-FISP ASL, a modified look-locker inversion recovery (MOLLI) sequence and standard morphological sequences (12 minute scan time). Mean renal perfusion and T1-relaxation times were calculated for the renal cortex. Inter-study and inter-reader reproducibility of MRI parameters were tested in addition to the pharmacological effect of Captopril on MRI parameters.

RESULTS

Inter-study reproducibility of ASL-based perfusion analysis was excellent with an intraclass correlation coefficient (ICC) of 0.77. Mean perfusion and T1-values did not differ between the two examinations under baseline conditions (369±48 vs. 369±39 ml/min/100g; 1116±71 vs. 1100±45 ms). Inter-rater agreement of perfusion analysis was also excellent, with an ICC of 0.97. After application of Captopril, the mean cortical kidney perfusion increased significantly by 22% (369±48 vs. 452±56 ml/min/100g, $p<0.001$), while cortical T1 times remained stable (1116 vs. 1161 ms). Statistical power analysis showed that only a small sample size is necessary to capture a significant change in kidney perfusion after pharmacological intervention with a high statistical power (8 volunteers for a statistical power of 95%).

CONCLUSION

ASL and T1 mapping provide functional MRI parameters with high inter-study and inter-rater reproducibility and are useful to measure the effect of pharmacological intervention with a low number of study participants.

CLINICAL RELEVANCE/APPLICATION

We show that ASL can rapidly quantify pharmacologically induced changes in kidney perfusion and believe that fMRI can be a beneficial tool to study effects on the kidney in drug development trials.

SSA10-04 Assessment of Renal Fibrosis with T1-mapping: An Experimental Study in a Rat of Unilateral Ureteral

Obstruction

Sunday, Nov. 26 11:15AM - 11:25AM Room: E351

Participants
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PURPOSE

To investigate the potential of magnetic resonance imaging (MRI) T1-mapping, using a look-locker inversion recovery sequence from 3.0T clinical MR scanner, in assessment of renal fibrosis using a rat model of unilateral ureteral obstruction (UUO).

METHOD AND MATERIALS

This study was approved by the institutional animal care and use committee. UUO was created in each of 36 rats. UUO-A group with 6 rats, longitudinal T1-mapping was performed before the UUO (day 0) and on days 1, 3, 5, 10, and 15 after the UUO and was followed by histopathologic analysis (one rat died on 11 days after the UUO). Six rats from UUO-B group (n = 30) were examined at each of five time points on days 0, 1, 3, 5 and 10 after the UUO. Four rats from Sham group (n = 12) were examined on days 1, 5, and 15 after UUO. Hematoxylin-eosin, Masson trichrome staining and a-smooth muscle actin (a-SMA) were performed. T1 relaxation times of renal parenchyma were analyzed and correlated with a-SMA expression level.

RESULTS

Histopathologic examination revealed typical renal fibrosis on the side with UUO. The T1 relaxation times increased over time on the UUO side, Mean T1 relaxation times with day 0, 1, 3, 5, 10, and 15 after the UUO were 1168.41 ±76.73, 1269.94 ±91.47, 1516.37 ±103.59, 1550.41 ±115.96, 1696.57 ±85.60, 1852.46 ±137.39 ms, respectively. Sham rats were 1215.13 ±80.77, 1194.47 ±51.51, 1232.28 ±57.48 ms, respectively. Mean T1 relaxation times associated positively ($r = 0.854$ $P < 0.001$) with a-SMA expression level.

CONCLUSION

In this model, renal fibrosis was detected with T1 mapping; the degree of fibrosis was correlated with degree of increase in T1 relaxation times measurements.

CLINICAL RELEVANCE/APPLICATION

T1-mapping shows great potential in noninvasive assessment of renal fibrosis induced by UUO. T1-mapping may provide a useful tool in Assessment of renal fibrosis.

SSA10-05 Glomerular Filtration Rate: CT Measurement from Fractional Renal Accumulation of Iodinated Contrast Material

Sunday, Nov. 26 11:25AM - 11:35AM Room: E351

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PURPOSE

To present a convenient, rapid CT measurement of split glomerular filtration rate (GFR) by using nephrographic phase CT acquisition, and compare it with renal dynamic imaging Gates method.

METHOD AND MATERIALS

This prospective study was approved by our institutional review board. Twenty patients with renal tumors referred for multiphasic CT and the 99mTc-DTPA renal dynamic imaging for preoperative evaluation were prospectively included. The multiphasic CT consisted of non-contrast, arterial, venous, and nephrographic phase acquisition. The latter was performed at 120 seconds after the arterial phase acquisition. The amount of the iodinated CM accumulated in the kidney (CMkidney) at the nephrographic phase was calculated as $Volume_{kidney} \times (HU_{nephrographic} - HU_{precontrast}) / F$, in which the F is the conversion factor between the iodine concentration and the CT number enhancement. The total amount of the CM administration (CMtotal) was known and could be calculated as the product of the volume of the CM injection and the iodine concentration (370mgI/ml). The fractional renal accumulation (FRA) of the iodinated CM was calculated as the ratio of the CMkidney to the CMtotal (FRA= CMkidney / CMtotal). The FRA was then correlated with 99mTc-DTPA dynamic imaging single-kidney Gates-GFR. From this correlation a formula was derived for single-kidney CT-GFR calculation, which in turn was compared with single-kidney Gates-GFR by using correlation analysis and Bland-Altman plots, with employing a leave-one-out procedure to ensure robustness of our findings.

RESULTS

The FRA (x) in mean ± SD was 2.97% ± 1.04%, correlated well ($r=0.90$, $p<0.001$) with single-kidney Gates-GFR (y), producing regression equation: $y=1452.6*x+1.36$ for single-kidney CT-GFR calculation. Single-kidney CT-GFR (44.33±15.27ml/min) correlated

well (r=0.89, p<0.001) with single-kidney Gates-GFR (44.47±16.79 ml/min). Bland-Altman plots demonstrated that the 95%CI of measurement deviation of the FRA between the two methods is ±14.82 ml/min without systemic bias (p=0.902).

CONCLUSION

A convenient, rapid CT measurement of split renal function was presented, which correlates and agrees well with the reference standard, therefore could be used as a one-stop-shop technique for preoperative evaluation of renal morphology and split function of renal tumors, without additional radiation dose.

CLINICAL RELEVANCE/APPLICATION

A convenient, rapid CT GFR measurement without additional radiation dose

SSA10-06 Renal Size Measurements on Pre- TAVR CT Angiogram as a Predictor of Post Procedure Acute Kidney Injury

Sunday, Nov. 26 11:35AM - 11:45AM Room: E351

Participants
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PURPOSE

We aimed to correlate renal size measurements such as renal length, renal parenchymal area and renal cortical area on pre-TAVR CT angiogram with post procedure acute kidney injury (AKI)

METHOD AND MATERIALS

This is a single-center retrospective cohort study of 101 TAVR patients (10/2013 to 5/2016). Post-TAVR AKI was defined by Kidney Disease: Improving Global Outcomes (KDIGO) SCr-based criteria. Demographic and clinical data were extracted from medical records. Pre-TAVR CT angiograms were analyzed using an Aquarius 3D Workstation (TeraRecon, San Mateo, CA).Various measurements including renal length, renal parenchymal area and renal cortical area were evaluated by 2 independent, blinded readers from a midline sagittal image reconstructed from axial and coronal images. Univariate comparisons between patients who did and did not develop AKI were made for radiologic measurements using t-test and Chi-square test as appropriate. Multivariable logistic regression was used to assess association of renal length, renal parenchymal area and cortical area with post-TAVR AKI with adjustment for pre-procedural renal function and other clinical predictors that were significant for association in univariate analysis (p<0.05).

RESULTS

Acute kidney injury, occurred in 20 of 101 patients after TAVR. Univariate assessments of characteristics of subjects who did and did not develop post-TAVR AKI are shown in Table1. Combined renal length of both kidneys (p-value 0.023, OR= 0.715, 95% CI 0.535.0.956), combined bilateral renal parenchymal area (p-value 0.025, OR= 0.955, 95% CI 0.918, 0.994) and combined bilateral renal cortical area (p-value 0.021 OR= 0.935, 95% CI 0.880, 0.993) were smaller in patients who developed post-TAVR AKI.

CONCLUSION

Predictors of post TAVR acute kidney injury include combined renal length, renal parenchymal area and renal cortical area.

CLINICAL RELEVANCE/APPLICATION

It is important to identify imaging characteristics that are associated with increased risk of AKI and other adverse post-procedural outcomes after TAVR so that better targeted preventions and interventions can be designed to mitigate these outcomes in the peri-procedural setting

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Suhny Abbara, MD - 2014 Honored EducatorSuhny Abbara, MD - 2017 Honored Educator

SSA10-07 Dual Contrast K-Edge Renal Perfusion Imaging Using Spectral Photon-Counting CT

Sunday, Nov. 26 11:45AM - 11:55AM Room: E351

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PURPOSE

To perform quantitative dynamic iodine and gadolinium renal perfusion imaging in vivo using spectral photon-counting computed tomography (SPCCT)

METHOD AND MATERIALS

Dynamic renal perfusion imaging was performed in 2 rabbits using SPCCT with multiple energy bins (Philips Healthcare, Haifa, Israel), with a voxel size of 0.25*0.25*0.25 mm, every 1.5 seconds over a period of 45 seconds starting after a simultaneous intravenous administration of 9 ml of gadolinium (78.5mg of Gd /ml, 3 ml/kg, Dotarem, Guerbet), and 3 ml of iodine (400 mg of I /ml, 1 ml/kg, Iomeron, Bracco). Acquisition was performed under 2 conditions: baseline and dopamine infusion. SPCCT provided conventional CT, material decomposition water/iodine and gadolinium specific K-edge images. Aortic and cortical time-attenuation curves were modeled to measure time to peak (TTP) and mean transit time (MTT) using a validated gamma variate model. Measurements of Gd K-edge and iodine perfusion were compared using Pearson correlation analysis with the reference method using conventional CT images.

RESULTS

SPCCT provided high resolution conventional HU, specific gadolinium K-edge and iodine material decomposition images of the cortex and the medulla (Fig A). MTT and TTP using K-edge of gadolinium and iodine material decomposition images correlated significantly with HU images with a R=0.97 and R=0.99 for MTT and R=0.86 and R=1 for TTP respectively ($p<0.05$)(Fig B). Thus, increase of MTT from 9.1±0.3 seconds to 10.5±0.1 seconds after dopamine infusion could be quantified on both K-edge gadolinium specific perfusion images and conventional HU Images.

CONCLUSION

SPCCT allows high resolution dynamic dual contrast kidney perfusion imaging and quantification with gamma variate modeling using either conventional HU, iodine and gadolinium K-edge specific imaging.

CLINICAL RELEVANCE/APPLICATION

Spectral photon-counting CT allows to perform renal perfusion assessment using gadolinium K-edge images, iodine images as well as conventional CT images.

SSA10-08 Determination of Single-Kidney Glomerular Filtration Rate (GFR) With CT Urography versus Renal Dynamic Imaging Gates Method

Sunday, Nov. 26 11:55AM - 12:05PM Room: E351

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PURPOSE

To present a single-kidney CT-GFR measurement by using images from CT urography, and compare it with renal dynamic imaging Gates method (Gates-GFR).

METHOD AND MATERIALS

This prospective study was approved by our institutional review board, and written informed consent was obtained from all patients. Thirty-six patients with hydronephrosis referred for CT urography and the 99mTc-DTPA renal dynamic imaging were prospectively included after informed consent. The CT protocol included non-contrast scan, nephrographic, and excretory phase. The CT-GFR was calculated by dividing the CT number increments of the urinary system between the nephrographic and excretory phase (CTNIurinary-system) by the products of iodine concentration in the aorta and the time (Productsconcentr-time), then multiplied by (1- hematocrit), which was then split into single-kidney CT-GFR and compared with single-kidney Gates-GFR by using paired t-test, correlation analysis, and Bland-Altman plots.

RESULTS

Paired difference between single-kidney CT-GFR (45.02 ± 13.91) and single-kidney Gates-GFR (51.21 ± 14.76) was 6.19 ± 5.63 ml/min, $p<0.001$, demonstrating 12.1% systematic underestimation with ±11.03 ml/min (±21.5%) measurement deviation. A good correlation was revealed between both measurements ($r=0.87$, $p<0.001$).

CONCLUSION

The proposed single-kidney CT-GFR correlates and agrees well with the reference standard despite a systematic underestimation (12.1%), therefore could be used as an one-stop-shop CT technique for evaluating urinary tract morphology and split renal function without additional radiation dose.

CLINICAL RELEVANCE/APPLICATION

The proposed technique could be used as an one-stop-shop CT technique for evaluating urinary tract morphology and split renal function without additional radiation dose.

SSA10-09 Multiparametric MRI (mpMRI) Of Renal Transplant: Preliminary Results and Repeatability Study in Patients with Stable Renal Function

Sunday, Nov. 26 12:05PM - 12:15PM Room: E351

Participants
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PURPOSE

To assess feasibility and test-retest repeatability of quantitative mpMRI parameters of diffusion, perfusion and hypoxia in renal transplant (Tx).

METHOD AND MATERIALS

11 patients (M/F 5/6, mean age 57y), 10 with functional renal Tx (estimated MDRD serum eGFR 48-84 ml/min/1.73m2) and 1 with chronic renal dysfunction (GFR 24.6) were prospectively enrolled. All patients underwent mpMRI at 1.5T (Aera, Siemens) including intravoxel-incoherent motion DWI (IVIM-DWI), DTI, BOLD and DCE-MRI renography with injection of 4 ml macrocyclic gadolinium agent (Dotarem). IVIM-DWI and BOLD signal curves, and DTI FA values, were measured from circular ROIs placed at the upper, middle and lower renal Tx poles. IVIM-DWI parameters (true diffusion D, pseudodiffusion D*, perfusion fraction PF and ADC) were obtained by Bayesian fitting. R2* transverse relaxation rate was obtained by monoexponential fit. Volume-averaged concentration-time curves obtained from DCE-MRI data for Cx, Med, and iliac artery were analyzed according to a previously validated three-compartment model to extract GFR, Cx and Med renal plasma flow (RPF) and mean transit time (MTT). Test-retest repeatability was assessed in 5 patients (average scan delay 24d) by coefficient of variation (CV).

RESULTS

IVIM-DWI parameters were highly repeatable (CV<5%), except for PF (CV Cx/Med 7.8%/14.6%) and D* (CV Cx/Med 32.7%/20.3%). R2* and FA had acceptable repeatability (CV<15%). DCE-MRI had acceptable repeatability for GFR (CV 12.18%), and poorer repeatability for RPF and MTT (CV 14-30%). FA Med was significantly higher compared to Cx (0.37±0.08 vs 0.18±0.06, p=0.0039). Cx RPF was significantly higher compared to Med RPF (433.3±121.6 vs 84.8±20.5 ml/min, p=0.0156). There was no significant correlation between serum eGFR and MRI parameters, between IVIM-DWI or BOLD and DCE-MRI parameters.

CONCLUSION

Quantitative mpMRI is moderately-to-highly repeatable in renal Tx. All parameter values agreed with literature values for patients with functional renal Tx, except for D* and Cx R2*, which were higher than published values.

CLINICAL RELEVANCE/APPLICATION

Knowledge of test-retest repeatability allows identification of differences in mpMRI-derived parameters that reflect intrinsic renal dysfunction rather than normal physiological variation and measurement noise. The value of mpMRI-derived metrics for characterizing renal Tx dysfunction will be investigated in a larger study.

SSA11

Genitourinary (Renal and Adrenal Imaging)

Sunday, Nov. 26 10:45AM - 12:15PM Room: E353B

CT GU MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSA11-01 Evaluation of Renal Lesions Using Contrast-Enhanced Ultrasound (CEUS): A 10-Year Retrospective Mono-Center Analysis

Sunday, Nov. 26 10:45AM - 10:55AM Room: E353B

Participants
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PURPOSE

To investigate the usefulness of contrast-enhanced ultrasound (CEUS) in the evaluation of renal masses.

METHOD AND MATERIALS

This institutional review board approved retrospective study included a total of 255 patients with a single renal mass with imaging studies between 2005 and 2015. Patient ages ranged from 18 to 86 with (mean age 62 years; SD ± 13). CEUS was used for determining malignancy or benignancy and initial findings were correlated with the histopathological outcome. Out of the 255 renal masses a total of 212 lesions were malignant (83,1%) and 43 were found to be benign (16,9%). Diagnostic accuracy was tested by using the histopathological diagnosis as the gold standard.

RESULTS

CEUS showed a sensitivity of 99.1% (95% confidence interval (CI): 96.7%, 99.9%), a specificity of 80.5% (95% CI: 65.1%, 91.2%), a positive predictive value (PPV) of 96.4% (95% CI: 93.0%, 98.4%) and a negative predictive value (NPV) of 94.3% (95% CI: 80.8%, 99.3%). Kappa for diagnostic accuracy was K= 0.85 (95% CI: 0.75, 0.94) Out of the 212 malignant lesions a total of 130 clear cell renal carcinomas, 59 papillary renal cell carcinomas, 7 chromophobe renal cell carcinomas, 4 combined clear cell and papillary renal cell carcinomas and 12 other malignant lesions, e.g. metastases, were diagnosed. Out of the 43 benignant lesions a total 10 angiomyolipomas, 3 oncocytomas, 8 benignant renal cysts and 22 other benignant lesions, e.g. renal adenomas, were diagnosed. 10 lesions were falsely identified as malignant or benign, whereas 8 lesions were false-positive and 2 lesions false negative. The 8 false-positive lesions included 5 oncocytomas or angiomyolipomas and 3 Bosniak category III cystic lesions.

CONCLUSION

CEUS is an useful method, which can be used to differentiate between malignant and benign renal lesions. In daily clinical routine, patients with contraindications for other imaging methods can particularly benefit using this method.

CLINICAL RELEVANCE/APPLICATION

CEUS can be used in daily clinical routine equipollent tool for the evaluation and diagnosis of renal masses and shows an excellent correlation to the histopathological outcome. In contrast to other imaging modalities like MRI and CT it is an easy, fast and cost-effective modality for the determination of renal masses and should be considered as an alternative for routine use.

SSA11-02 Optimizing Diffusion-Weighted Imaging of the Kidneys: Comparison between Simultaneous Multi-Slice and Integrated Slice-By-Slice Shimming Echo Planner Sequence

Sunday, Nov. 26 10:55AM - 11:05AM Room: E353B

Participants
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PURPOSE

To compare the image quality of diffusion-weighted imaging (DWI) of the kidneys acquired using a simultaneous multi-slice (SMS) and prototypic ss-epi sequence with integrated slice-specific dynamic shimming (iShim) at 3T. The difference in the apparent diffusion coefficient (ADC) was also evaluated.

METHOD AND MATERIALS

In this IRB-approved study, 28 subjects including 22 patients (9 with chronic kidney disease, 4 with Gitelman syndrome, 7 with IgA nephropathy, 2 with malignant hypertension) and 6 healthy volunteers underwent DWI of the kidneys at 3T using the SMS DWI sequence with CAIPIRINHA unaliasing technique and prototype ss-epi sequence with iShim. A TSE-T2WI sequence was acquired to evaluate the geometric distortion of DW images. The SNR, CNR, and ADC calculated by using five b-values (0, 80, 400, 800, and 1600s/mm2) of the kidney were measured. The coordinates of anatomic points of the anterior margins of both kidneys, the posterior angle of spinal canal, the middle posterior point of erector spinae were selected and the length between each pair of matched anatomic points from the TSE-T2WI and b0 maps of EPI were calculated by using an in-house developed software program. Subjective image quality was evaluated by two radiologists on a 5-point scale, and the presence of artifacts was recorded for each sequence. Acquisition time (AT) of the two sequences was also compared.

RESULTS

No statistical differences in the SNR and CNR of all the b-values were observed between SMS and iShim DWI (P>0.05). ADCs in the kidneys were comparable in the SMS and iShim sequences (1552.6±140.2 vs. 1543.3±170.7, P>0.05). Compared to iShim, the length of distortion in SMS sequence is smaller in phase direction (2.11±1.19 vs 2.87±1.70pixel) but larger in read direction (3.12±1.04 vs 2.87±1.71 pixel). The total length of distortion in SMS sequence is significantly smaller (3.87±1.23 vs 15.20±0.98 pixel, P<0.001). The AT was substantially decreased in SMS compared to iShim DWI (3:56 vs 8:28 min). Subjective image quality scores were not statistically different between the two sequences for both reviewers (SMS vs iShim, reviewer 1: 4.36 ± 0.68 vs. 4.32 ± 0.67, reviewer 2: 4.54 ± 0.64 vs. 4.29 ± 0.81, P > 0.05). Significantly fewer artifacts were observed in SMS DWI (8 vs. 21, P < 0.001).

CONCLUSION

Compared with the iShim DWI sequence, SMS DWI substantially reduced AT, distortion and artifacts while maintaining image quality and the stability of ADC values in kidney DWI.

CLINICAL RELEVANCE/APPLICATION

By considerably reducing the AT, distortion and artifacts while preserving image quality, SMS DWI may contribute to a more efficient and safer workflow in clinical practice.

SSA11-03 Noise Matters: Correction for Imaging Parameters Improves Performance of a Gaussian-Based Adrenal Nodule Characterization Algorithm

Sunday, Nov. 26 11:05AM - 11:15AM Room: E353B

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PURPOSE

Histogram analysis (HA) of indeterminate adrenal nodules has shown good sensitivity and high specificity for differentiating adenomas from nonadenomas, but requires post-processing that can hinder workflow. A Gaussian-based algorithm (GA) based on HA without the need for post-processing demonstrated similar performance. We sought to determine if normalizing noise can improve diagnostic performance of the GA in a biopsy-enriched sample of patients with either a history of cancer or a high risk of cancer.

METHOD AND MATERIALS

IRB-approved, HIPAA-compliant retrospective study evaluated 71 adrenal nodules (41 biopsied) on non-contrast CT using the GA based on region of interest histogram analysis with and without noise correction (normalization of effective mAs and slice thickness to published data). Two independent readers were blinded to final pathology. Lesions were characterized as malignant if biopsy-proven or likely benign due to pathology or imaging features (stability > 1 year, adrenal CT washout, MRI signal loss, or negative FDG PET/CT with a FDG positive primary). 66/71 patients had a history of cancer and 5 were high-risk patients. Inter-reader agreement was assessed using intraclass correlation coefficient (ICC) and Cohen's kappa. Sensitivity, specificity, and accuracy were compared between algorithms using the bootstrap.

RESULTS

Mean size of the adrenal nodules was 3.0 cm ± 2.0. 35 biopsied nodules were metastases. Of the 36 benign nodules, 6 were characterized by pathology and 30 by imaging. Inter-reader agreement was good for mean and s.d. of nodule attenuation (ICC=0.91-0.97) and identification of adenoma by both GAs (kappa=0.84-0.88). The GA with correction had significantly increased overall accuracy for adenoma than the non-corrected GA (79% vs. 64%, p=0.005), with higher specificity (87% vs. 46%, p<0.001) and a trend toward lower sensitivity (71% vs. 82%, p=0.07).

CONCLUSION

A Gaussian-based algorithm based on histogram analysis can be used to differentiate adenomas from non-adenomas without post processing; however, it is important to correct for imaging parameters to improve the performance of the algorithm.

CLINICAL RELEVANCE/APPLICATION

Correction for imaging parameters improves performance of a Gaussian-based adrenal nodule characterization algorithm for distinguishing adenomas from non-adenomas without additional post processing.

SSA11-04 Utility of Texture Analysis for Differentiation of Solid Adrenal Lesions

Sunday, Nov. 26 11:15AM - 11:25AM Room: E353B

Participants
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PURPOSE

Incidentally noted adrenal nodules are commonly encountered in clinical practice. While many prove to be benign on follow up imaging, some lesions remain indeterminate and result in more invasive workup, such as biopsy. To this end, the purpose of this study was to evaluate the utility of texture analysis for differentiation of lipid poor adenomas from other solid adrenal tumors on contrast enhanced computed tomography (CT).

METHOD AND MATERIALS

In this IRB approved study, patients with a contrast enhanced CT prior to a CT-guided adrenal biopsy between 2006 and 2014 were included. Texture analysis was performed using a commercially available research software program (TexRAD) that applies a filtration-histogram technique for characterizing tumor heterogeneity. The filtration step selectively filters and extracts texture features at different anatomical scales varying from 2mm (fine features) to 5mm (coarse features). Receiver operating characteristics (ROC) curve analysis was performed to assess sensitivity and specificity for differentiating between benign and malignant lesions.

RESULTS

Of the 124 lesions included for analyses, 43 were benign and 81 malignant. Amongst the unfiltered texture features, standard deviation, entropy and skewness were excellent discriminators of lesions demonstrating areas under the curve (AUC) greater than 0.9 ($p<0.0001$). Of these, entropy was the best parameter for discrimination of lesions with an AUC of 0.95. Using a threshold value of 4.42, entropy had a sensitivity and specificity of 95% and 88%, respectively, for differentiating lesions. Amongst the filtered texture features, entropy was the best discriminator of lesions with an AUC of 0.97 ($p<0.0001$). Using a threshold value of 4.83, the sensitivity and specificity for differentiating lesions were 81% and 100%, respectively. Mean positive pixel (MPP) was an excellent discriminator of lesions across different spatial filter sizes with AUCs ranging from 0.89 to 0.92 ($p<0.0001$).

CONCLUSION

Results demonstrate the effectiveness of texture analysis as a radiomic marker for characterizing incidentally noted adrenal nodules.

CLINICAL RELEVANCE/APPLICATION

The growing use of CT has led to an increase in detection of incidental adrenal lesions. Use of texture analysis to characterize such lesions may reduce the need for follow up imaging and/or invasive tissue sampling.

SSA11-05 Usefulness of CT Texture Analysis in Characterizing Renal Cancers

Sunday, Nov. 26 11:25AM - 11:35AM Room: E353B

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PURPOSE

Pre-surgical characterization of renal cancer histology and grade help to decide on treatment options, e.g., radical nephrectomy, nephron-sparing surgery, ablation or, in some cases, observation. We wanted to investigate the value of CT texture analysis (CTTA) in differentiating clear cell renal cancer (CCRCC) from papillary renal cell cancer (PRCC) and predicting the Fuhrman grade.

METHOD AND MATERIALS

In this retrospective institutional review board-approved, HIPAA-compliant study, 249 patients with CCRCC and 49 patients with PRCC who had pretreatment contrast-enhanced CT were identified from the pathology and radiology databases. The axial enhanced CT image of largest tumor cross section was uploaded to a cloud server with CTTA software (TexRad v3.9, Cambridge, UK). The maximum tumor diameter was recorded and texture analysis parameters of mean, entropy, kurtosis, maximum positive pixel (MPP) and skewness were determined using different spatial scaling factors (SSF 0-6). Logistic regression analysis was performed to determine if the CTTA parameters or tumor size correlated with the tumor histology and Fuhrman grade. Receiver operating

characteristic (ROC) analyses were created.

RESULTS

There was no significant difference in age, or maximum tumor diameter between the CCRCC and PRCC groups (p= 0.076 and 0.936, respectively). Entropy with medium (SSF3) and coarse filters (SSF5) were significantly higher in CCRCC than PRCC (p=0.05 for both). High Fuhrman stage (3 & 4) cancers were associated with larger tumor diameter and high entropy value with coarse filter (SSF6) (p<0.001 and p=0.001, respectively). The area under ROC curve (AUC) of entropy at SSF3 and SSF5 were 0.843 (0.782-0.905) and 0.841 (0.780-0.902), respectively, for differentiating CCRCC from PRCC. Entropy greater than 5.36 at coarse filter (SSF5) had sensitivity and specificity of 74% and 88%, respectively, for CCRCC.

CONCLUSION

The CTTA parameter of entropy at coarse spatial scaling filter may help to differentiate CCRCC from PRCC and to predict the Fuhrman stage.

CLINICAL RELEVANCE/APPLICATION

CTTA parameters may help to determine tumor biology and change management in some cases.

SSA11-06 Progression (Upgrade) Rate of Followed Bosniak Category IIF Complex Renal Cysts

Sunday, Nov. 26 11:35AM - 11:45AM Room: E353B

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PURPOSE

To evaluate progression (upgrade) rate of followed Bosniak category IIF complex renal cysts and malignancy rate on surgically resected lesions.

METHOD AND MATERIALS

This was an institutional review board-approved retrospective study. Imaging department database system was searched from January 1, 2008, to April 1, 2016, for Bosniak category IIF complex renal cysts found on contrast enhanced computed tomography or magnetic resonance imaging. Exclusion criteria were lesions smaller than 1.0 cm or without follow-up study. Stability of Bosniak category IIF lesions required a minimum of 6 months follow-up. Progression was considered when the follow-up study indicated upgrade of Bosniak category to III or IV. Pathologic results were evaluated in patients submitted to surgery and follow-up to look for recurrent or metastatic disease.

RESULTS

A total of 152 lesions (size range, 1-16 cm; average 3 cm) in 143 patients (107 men, 36 women; age-range, 31-94 years; average, 63 years) were included in the final analysis. Follow-up studies were performed from 6 to 118 months (average 28 months). Seven of 152 lesions (4.6%) progressed to Bosniak category III or IV on follow-up studies in one month to 4 years (average 20 months). Three of those were surgically removed, all of them diagnosed as malignant renal cell carcinoma (one clear cell and two papillary subtypes). Follow-up after surgery ranged from 16 to 30 months (average 24 months) and there was no evidence of recurrence or metastasis. From the remaining, one patient with Bosniak category III lesion had concomitant hepatocellular carcinoma and the renal lesion showed stability in one year-follow-up; one patient with Bosniak category IV lesion had advanced age (86 years) and the renal lesion also showed stability in one year-follow-up; and two patients lost follow-up in our institution.

CONCLUSION

Progression rate occurred for 4.6% of followed Bosniak category IIF lesions in one month to 4 years. All resected lesions were diagnosed as renal cell carcinomas.

CLINICAL RELEVANCE/APPLICATION

Although Bosniak category IIF cysts have low upgrade rate on follow-up studies, all surgically resected lesions were malignant neoplasms.

SSA11-07 Fat Quantification of Adrenal Masses Using 3D 6-point Dixon MR Imaging: Intermodality Agreement and Interobserver Reproducibility Study

Sunday, Nov. 26 11:45AM - 11:55AM Room: E353B

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PURPOSE

Three-dimensional (3D) 6-point Dixon fat fraction (DFF) techniques may enable fat quantification of adrenal masses. The purpose of this study was to assess the intermodality and interobserver agreement of fat quantification of adrenal masses obtained with 3D 6-point DFF imaging and two-dimensional (2D) dual-echo chemical shift GRE imaging (CSI).

METHOD AND MATERIALS

Two radiologists independently measured fat fraction in 27 mass lesions of 19 patients with adrenal masses. The adrenal lesions included 17 adrenal adenomas, 6 ACTH-independent macronodular adrenal hyperplasias, 2 metastatic adrenal tumors, 1 pheochromocytoma, and 1 myelolipoma. The CSI and DFF MR imaging were performed with a 3.0-T MR system. Quantitative measurements of signal intensity (SI) changes between in-phase and opposed-phase images were computed as follows: SI index = (SIin-SIop)/SIin, where SIin is SI on in-phase images and SIop is SI on opposed-phase images. Quantitative measurement of DFF was automatically calculated by proton density fat fraction (PDFF) maps. They placed regions of interest (ROI) in the mass on CSI and PDFF maps. Intermodality and interobsever agreement were determined by using 95% Bland-Altman limits of agreement and intraclass correlation coefficients (ICCs).

RESULTS

The intermodality agreement for fat quantification was good on CSI and PDFF maps; ICCs ranged from 0.62 to 0.64. The 95% limits of agreement ranged from 81.6% to 84.8%. ICCs for interobserver agreement in CSI and PDFF were 0.998 and 0.982, respectively. The 95% limits of agreement were 9.6% for CSI and 9.6% for PDFF.

CONCLUSION

In fat quantification of adrenal masses, 3D 6-point DFF technique at 3T yielded measurements and reproducibility similar to those of 2D dual-echo CSI.

CLINICAL RELEVANCE/APPLICATION

For fat quantification of adrenal masses on 3T MRI, 3D 6-point DFF technique is as useful as 2D dual-echo CSI.

SSA11-08 Subtype Differentiation of Small (< 4 cm) Solid Renal Mass Using Volumetric Histogram and Texture Analysis of Reduced Field-of-View Diffusion Weighted MRI at 3-T

Sunday, Nov. 26 11:55AM - 12:05PM Room: E353B

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PURPOSE

To evaluate the utility of volumetric histogram and texture analysis originated from reduced field-of-view (r-FOV) diffusion-weighted (DW) imaging for small (< 4 cm) solid renal mass subtypes at 3-T MR.

METHOD AND MATERIALS

In this institutional review board approved study, 70 patients with renal tumors were included in this retrospectively study. Volumetric apparent diffusion coefficient (ADC) maps were generated using all slices of the r-FOV DWI to obtain histogram and texture parameters, including the mean ADC, median ADC, 10th, 25th, 75th, 90th percentiles ADC, standard deviation (SD), skewness, kurtosis and entropy. Comparisons of above parameters were used by one-way analysis of variance, Student's t test and receiver operating characteristic (ROC) curves analysis.

RESULTS

A total of 70 pathologically proven renal tumors including 38 clear cell (ccRCC), 8 papillary (pRCC), 6 chromophobe (chRCC), 13 minimal fat angiomyolipoma (MFAML) and 5 oncocytoma (Onc) were enrolled in our analysis. The mean ADC, median ADC, 75th, 90th percentiles ADC of ccRCC was significantly higher than pRCC, chRCC, MFAML and Onc (all $P < 0.001$). The SD of Onc was significantly lower than that of ccRCC and pRCC ($P = 0.015$, 0.025, respectively). The entropy of MFAML was significantly lower than that of ccRCC and pRCC ($P = 0.001$, 0.009, respectively), and entropy of Onc was significantly lower than that of ccRCC, pRCC, and chRCC ($P = 0.001$, 0.004, 0.048 respectively). Mean ADC, median ADC, 10th, 25th, 75th, 90th percentiles ADC, SD and entropy of malignant tumors were significantly higher (all $P < 0.001$) than those of benign tumors. The 90th percentiles ADC achieved the highest AUC (0.814; 95% CI: 0.713, 0.916) in differentiating malignant renal tumors from benign ones.

CONCLUSION

Our study demonstrated the combination of r-FOV DWI and volumetric histogram and texture analysis of ADC values may have a certain value to help differentiate the majority of subtypes of small solid renal tumor, including benign and malignant lesions.

CLINICAL RELEVANCE/APPLICATION

Quantitative volumetric ADC histogram and texture analysis may have the potential to preoperatively characterize various subtypes of small solid renal tumors, which could ensure proper management options for patients.

SSA11-09 Prospective Evaluation of CT Size and Attenuation Measurement Agreement as Applied to Tumor Response Assessment in Metastatic Renal Cell Carcinoma Patients from Phase II of the Multi-Centre STAR Trial

Sunday, Nov. 26 12:05PM - 12:15PM Room: E353B

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PURPOSE

Response assessment in the setting of anti-angiogenic therapies is challenging due to discrepancies in tumor devascularisation versus shrinkage. Assessment of both tumor size and enhancement change may be more valid but requires robust methodology. We aimed to prospectively assess the level of observer agreement relating size and absolute versus normalised enhancement at different post-contrast phases in metastatic renal cell cancer.

METHOD AND MATERIALS

Following IRB approval and informed consent, 104 target lesions in 44 patients enrolled in a prospective multicentre phase II/III trial comparing tyrosine kinase inhibitor treatment strategies in metastatic renal cell carcinoma were measured by two radiologists at baseline and 12 week follow-up CT. Percentage change in sum of TL longest diameters and percentage change in tumor enhancement, assessed both in the arterial and portal venous phases, and with normalised values relative to aortic attenuation were noted for each observer using semi-automated commercial software. Agreement between readings was assessed by intra-class correlation coefficients (ICC) and Bland-Altman plots.

RESULTS

Excellent inter-rater agreement was seen for target SLD measurements ICC 0.93[0.88-0.96] mean difference 1.68, 95% LOA [-39.22-42.58] with good agreement for percentage size change at follow up 0.60[0.38-0.76]1.52[-31.98-35.03]. Moderate agreement was seen for absolute and normalised mean arterial enhancement values 0.42[0.13-0.65]-9.8[-102.6-83.4], 0.58[0.33-0.76]-5.2[-49.3-38.9] with good agreement for percent change respectively 0.72[0.52-0.85],-5.2[-49.3-38.9] 0.89[0.79-0.94]-0.3[-29.1-29.4]. Agreement was higher for absolute 0.78[0.62-0.88],2.9[-30.6-36.4] and normalised mean venous enhancement values 0.63[0.38-0.79], 0.04[-0.39-0.43] and percent change: 0.89[0.798-0.947]-0.33[-29.13-29.4],0.79[0.62-0.89]2.9[-38-43.8].

CONCLUSION

Excellent agreement was noted for size change with moderate to good agreement for enhancement characteristics. Normalised enhancement values improved observer agreement which was higher for the venous phase. Concordance for percentage change in normalised enhancement was good irrespective of enhancement phase.

CLINICAL RELEVANCE/APPLICATION

Good to excellent inter-observer agreement for normalised tumor enhancement values is a further step to achieving more robust response evaluation of angiogenic tumors with size and enhancement criteria.

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SSA12

Science Session with Keynote: Informatics (Artificial Intelligence and Deep Learning in Medical Imaging)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S403A

IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSA12-01 Informatics Keynote Speaker: Emerging Trends in Medical Artificial Intelligence

Sunday, Nov. 26 10:45AM - 10:55AM Room: S403A

Participants
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ABSTRACT

Artificial intelligence (AI) including deep learning (DL) and natural language processing (NLP) is one of key topics for future radiology. DL, which is a class of machine learning algorithms, has produced breakthrough results in many areas including image recognition recently. Ideally, conventional deep learning methods in radiology require large amount s of supervised datasets, such as over thousands of diagnostic images and collect answers. So large scale of medical image databases have been built in many institutions throughout the world. Recent advantage in AI shows more efficient and improved methods of transfer learning and reinforcement learning. Automated image captioning with deep learning opens up the possibility of collaborative reporting workflows by AI and radiologists. A classification system of automated driving based on six different levels (ranging from none to fully automated systems) was published in 2014 by Society of Automotive Engineers (SAE). Similar AI classifications in radiology is proposed as follows: level 0. Image preprocessing without AI; level 1. One simple image recognition; level 2. Complex image recognitions at multiple points; level 3. Image diagnosis equivalent to human being; level 4. Image diagnosis beyond human being (i.e. image recognition of MRI k-space data).

SSA12-02 Automated Risk Stratification of Suspicious Lung Nodules Using 3D Convolutional Neural Network with Modified Network-In-Network Architecture

Sunday, Nov. 26 10:55AM - 11:05AM Room: S403A

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CONCLUSION

An automated algorithm was developed to predict risk of malignancy given a suspicious lung nodule, achieving overall AUC of 0.892 and log-loss of 0.424.

Background

Accurate prediction of lung nodules' malignancy risk has important clinical implications for treatment and diagnostic decisions. There are established imaging features to identify definitively benign nodules, but accurate stratification of intermediate to high risk nodules remains challenging. Using a 3D convolutional neural networks (CNN), we developed an algorithm to automatically analyze the risk of malignancy for a given suspicious lung nodule.

Evaluation

This study included 1600 patients from the National Lung Cancer Screening Trial (NLST) with 324 biopsy-proven lung cancer and 180 suspicious but confirmed benign lung nodules. Nodule location and diameter were manually annotated by a radiology resident under the supervision of a chest radiology attending. We designed an 18-layered 3D classifier neural network inspired by the Network-in-Network architecture, further modified to include batch normalization and dropouts. Transfer learning was conducted via pre-trained weights from an in-house nodule localizer. Briefly, the localizer network uses artificial nodule generation followed by a modified fully convolutional network approach to localize medium to high risk nodules. Our classifier network used binary cross-entropy loss function, ADAM optimizer, learning rate of 0.001, and batch size of 64. Data augmentation was conducted to generate

409,600 samples. Training time took 3.3 hours on NVIDIA GTX 1080. Final model achieved log-loss of 0.424 and AUC of 0.892. Error analysis was conducted with examples of confident corrects, confident incorrects, and random cases.

Discussion

We demonstrate a 3D deep learning algorithm that can automatically assess a lung nodule's risk of malignancy. If externally validated, this algorithm can address an important need for risk stratification of lung nodules in category of intermediate to high risk for malignancy. Of note, the algorithm still has capacity for improvement by using the entire NLST cohort and conducting hyperparameter optimization.

SSA12-03 Convolutional Neural Network in Differentiating Head MRIs from Other Methods in Diagnostic Imaging

Sunday, Nov. 26 11:05AM - 11:15AM Room: S403A

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CONCLUSION

To date, there is no open-source, labeled medical imaging dataset comparable to ImageNet because the acquisition of these images is too laborious and expensive. However, AlexNet proved to be a powerful tool for sorting head MRI from other imaging modalities. This concept could be expanded to other exam types, in order to create an unblended dataset for further use in deep learning medical applications

Background

Convolutional neural network is an artificial intelligence technique capable of learning on its own to recognize an image through its features and similarities, and has been used to enhance human capabilities in many fields, including diagnostic imaging. The biggest challenge in training a neural network for any utilization is to obtain a large-scale database of properly labeled images that the neural network can use to learn. The largest know database of labeled images is ImageNet, which contains more than 15 million natural images (not medical) collected from the web, but there is no comparable source of medical images available due to several difficulties in data labeling. One of these difficulties arise from the lack of standardization for the names of studies in DICOM metadata. This study's purpose is to train a neural network to differentiate head MRIs from other imaging modalities, and test its accuracy in order to create a medical dataset of high definition, properly sorted images that could be used in further researches applying deep learning in medical applications

Evaluation

Up to 358,180 anonymized studies were split into two groups, the first one containing only head MRIs (67,374 images), and the second one composed of MRIs of other body parts and different diagnostic modalities such as radiographs, ultrasound and computed tomography (290,806 images). This dataset was randomized into training (70%), validation (20%) and test (10%) subsets. AlexNet was trained from scratch using stochastic gradient descent, with sigmoid decay of the initial training rate of 0.01 in 60 epochs.

Discussion

In the present study, AlexNet achieved 99.8% top-1 accuracy for differentiating head MRIs from other exams, with a loss of 0.00012 for the training subset and 0.004 for the validation subset

SSA12-04 Automated Detection and Classification of Pediatric Urinary Tract Dilation (Hydronephrosis) with Convolutional Neural Networks

Sunday, Nov. 26 11:15AM - 11:25AM Room: S403A

Participants
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CONCLUSION

Deep learning may be suitable for detecting the presence and extent of UT dilation in children. We take a first step in this direction and show a path for future work.

Background

Early detection and management of urinary tract (UT) dilation in children is necessary to prevent the development of future uropathies. Ultrasound (US) is the primary modality for the diagnosis and grading of UT dilation; however, despite ongoing attempts at creating consensus-based reporting parameters and lexicon, pediatric renal US remains prone to substantial inter- and intraobserver variability. Thus, an automated system could be helpful for standardization. To this end, we propose a semi-automated system for detecting the presence and degree of UT dilation on renal US using deep learning. To our knowledge, this is the first work of its kind.

Evaluation

We developed two deep neural networks for UT dilation classification: one is a binary classifier trained to detect the presence or absence of UT dilation. The other grades UT dilation on a scale of 0-2 based on the extent of calyceal dilation (no calyceal dilation, central calyceal dilation, or peripheral calyceal dilation). The preliminary dataset consists of single sagittal renal US images split into a training set containing 609 samples and a test set containing 71 samples. After training the binary classifier had a test set accuracy of 94% and area under the curve 0.96. The multi-label classifier had an accuracy of 85% and Cohen's kappa coefficient 0.75.

Discussion

We demonstrate a highly accurate binary classifier for pediatric UT dilation using deep neural networks. Our multi-label classifier performs somewhat worse than the binary classifier though it approaches published values of intra- and interobserver variability based on Cohen's kappa. We speculate that the relatively poor performance of the multi-label classifier stems from the small size of our dataset. Future work will focus on incorporating a larger and more diverse data stream so the model may be evaluated against standard classification schemes such as the UTD classification system. Our goal is to integrate the classifier into clinical workflow to improve standardization and diagnostic accuracy.

SSA12-05 Cardioblaster: Determination of Clinical Cardiac Parameters from Short-Axis MRI Scans using Deep Learning

Sunday, Nov. 26 11:25AM - 11:35AM Room: S403A

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PURPOSE

To establish fully automated determination of clinical cardiac parameters on 2D short axis cine MRI stacks using deep learning and to compare the results with human expert performance.

METHOD AND MATERIALS

Clinical cardiac parameters are of great importance for early detection and therapy monitoring of ischemic and non-ischemic heart disease. Manual determination of these parameters takes experts more than 20 minutes (Caudron et al.2012). Furthermore, Caudron et al. (2012) reports the following intraclass correlation coefficient (ICC) values for two human experts: ESV 99/92, EDV 99/89, VM 85/54, SV 87/81, EF 95/80. A training set, consisting of 253 manually segmented cardiac MRIs of a in house (n=193) and the Data Science Bowl Cardiac Challenge (n=60) data set, was assembled. Validation was performed on a in house (n=309), the Data Science Bowl Cardiac Challenge (n=602), the MICCAI 2009 LV Segmentation Challenge (n=44), and the Right Ventricular Segmentation Challenge (n=32) data sets. The neural network was implemented in TensorFlow. End systolic volume (ESV), end diastolic volume (ESV), ventricular mass (VM), ejection fraction (EF), and stroke volume (SV) for the left (LV) and right ventricle (RV) were calculated using Python.

RESULTS

The ICC between the automated segmentation and the ground truth is: ESV 92-96/92-96 (LV/RV/ in %), EDV 94-99/92-96, VM 94-95/83-83, SV 90-98/84-92, EF 80-98/87-96 for the four distinct data sets. Caudron et al. (2012) reports the following ICC values for two human experts: ESV 99/92, EDV 99/89, VM 85/54, SV 87/81, EF 95/80.

CONCLUSION

This study demonstrates a reliable method for automatically determining clinical cardiac parameters such as ESV, EDV, EF, SV and VM. The ICC results show a comparable or higher performance in comparison to human experts, especially in the RV. Furthermore, we applied the concept of transfer learning of a pre-trained neural network to a new environment. This effectively eliminates the associated costs in introducing a neural network in a new setting.

CLINICAL RELEVANCE/APPLICATION

Introducing a neural network in the routine clinical workflow of cardiac MR image analysis. Transfer learning could effectively eliminate the associated time and cost in the future.

SSA12-06 Generating Heatmaps to Visualize the Evidence of Deep Learning Based Diagnosis of Chest X-Rays

Sunday, Nov. 26 11:35AM - 11:45AM Room: S403A

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PURPOSE

For radiologists to develop confidence in a deep learning diagnostic algorithm, it is essential that the algorithm be able to visually demonstrate the evidence for the diagnosis or disease tag. We describe the development of a method that highlights the region(s) of a chest X-ray (CXR) responsible for a deep learning algorithm diagnosis.

METHOD AND MATERIALS

Using 24,384 CXRs, we trained 18-layer deep residual convolutional neural networks to predict if a chest X-ray was normal or abnormal, and to detect the presence of 'cardiomegaly, 'opacity', and 'pleural effusion' in a CXR. We then applied a method called prediction difference analysis for visualization and interpretation of the trained models. The contribution of each patch in the image is estimated as the degree by which the prediction changes if that patch is replaced with an average normal patch. This method was used to generate a relevance score for each pixel which is consequently visualized as a heat map.

RESULTS

We used a 60-20-20 split for train, validation and test sets. The trained neural network showed an area under the ROC curve of 0.89, 0.92, 0.84, 0.91 for tagging abnormal, cardiomegaly, opacity and pleural effusion respectively on the test set. The visualization pipeline is used to generate heatmaps highlighting the enlarged heart, opacities and the fluid corresponding to the cardiomegaly, opacity and pleural effusion tags.

CONCLUSION

We trained and tested a deep learning algorithm which accurately classifies and assigns clinically relevant tags to CXRs. Further, we applied a visualization method that generates heatmaps highlighting the most relevant parts of the CXR. The visualization method is broadly applicable to other kinds of X-rays, and to other deep learning algorithms. Future work will focus on formally validating the accuracy of the visualization, by measuring overlap between radiologist annotation and algorithm-generated heatmap.

CLINICAL RELEVANCE/APPLICATION

Heatmaps highlighting evidence for disease tags will provide clinical users with crucial visual cues that could ease their decision to accept or reject a deep learning based chest x-ray diagnosis.

SSA12-07 Assessment of Critical Feeding Tube Malpositions on Radiographs Using Deep Learning

Sunday, Nov. 26 11:45AM - 11:55AM Room: S403A

Awards
Trainee Research Prize - Medical Student

Participants
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PURPOSE

Assess the efficacy of deep convolutional neural networks (DCNNs) in detection of critical enteric feeding tube malpositions on radiographs.

METHOD AND MATERIALS

555 de-identified HIPAA compliant frontal view chest and abdominal radiographs were obtained, consisting of 147 (147/555, 26.5%) x-rays of bronchial insertions and 408 (408/555, 73.5%) non-critical x-rays, including normal course, normal chest, and normal abdominal x-rays. The ground-truth classification for enteric feeding tube placement was performed by two board-certified radiologists. The radiographs were fed into the AlexNet deep convolutional neural network, which included models untrained and that pretrained on ImageNet. The Caffe framework was utilized. Images were split into training (396/555, 71.4%), validation (44/555, 7.9%), and test (115/555, 20.7%). The training dataset was augmented and increased in size to 6336 images, using a combination of rotations, non-rigid transformation, and contrast-limited adaptive histogram equalization (CLAHE). Receiver operating characteristic (ROC) and area-under-the-curves (AUC) on the test data were use to assess the models. Statistical differences among the AUCs were obtained. $P < 0.05$ was considered statistically significant.

RESULTS

The pre-trained AlexNet algorithm had an AUC of 0.84 (95% CI: 0.65-0.84) and the untrained AlexNet had an AUC of 0.75 (95% CI: 0.75-0.91). The difference between the performance of the algorithms was statistically significant (p=0.049).

CONCLUSION

DCNN's are promising in classifying critical vs. non-critical feeding tube placements with an AUC of 0.84. Networks pre-trained on over one million everyday color images outperformed untrained networks (p=0.049), demonstrating the utility of transfer learning in medical imaging. More training data, pre-processing techniques, and other neural network architectures could further improve these results.

CLINICAL RELEVANCE/APPLICATION

DCNNs may allow for more rapid identification and communication of critical feeding tube malpositions.

SSA12-08 Nodule Slice Detection Based on Weak Labels of Lung CT

Sunday, Nov. 26 11:55AM - 12:05PM Room: S403A

Participants
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PURPOSE

Early detection of lung nodules is essential to the diagnosis and treatment of lung cancer. In this paper, the authors proposed an improved method to automatically identify the slices that contain lung nodules from a computed tomography (CT) volume. This deep learning based method aims to serve as a tool for fast screening of lung nodules, in order to reduce CT reading time for radiologists.

METHOD AND MATERIALS

The proposed deep learning model combines convolutional neural networks (CNN) and variable length bidirectional long short term memory networks (LSTM). It relies on a supervised learning approach that only requires weak labels on the training dataset. The labels indicate the CT slices that contain a nodule, but not the exact location of the nodule. The proposed method was evaluated on two datasets with 5-folds cross-validation. Dataset (1) was collected from two 3A grade hospitals in China. It contained 1726 CT volumes (half normal, half contain nodules). Each volume was labeled by at least three radiologists with more than five years of experience. Dataset (2) was the publicly available LIDC-IDRI database containing 888 scans, which underwent a two-phase annotation process by four experienced radiologists.

RESULTS

From dataset (1), our method reached high detection sensitivity of 88.2% and 0.5 false positives per CT volume. From dataset (2), we achieved a high sensitivity of 86.9% with an average of 0.8 false positives per subject, which outperformed the best results (sensitivity 86.4%) in LUng Nodule Analysis (LUNA16) nodule detection challenge on the same dataset.

CONCLUSION

The results demonstrated that the proposed method achieved high sensitivity and specificity in identifying CT slices that contain lung nodules. This deep learning model was shown to outperform the existing computer-aided diagnosis methods with higher sensitivity. The proposed method has promising potential in reducing CT reading time for radiologists, and it only requires weak labels on the training data for easy implementation.

CLINICAL RELEVANCE/APPLICATION

We developed a new method using deep learning networks to detect lung CT slices where the nodules located in, which can assist the radiologists to read CT and reduce their reading time.

SSA12-09 Automated Detection of Large Pneumothoraces on Chest Radiography Using Deep Convolutional Neural Networks

Sunday, Nov. 26 12:05PM - 12:15PM Room: S403A

Participants
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Raja Gali, MS, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Assess the efficacy of deep convolutional neural networks (DCNNs) in differentiating large pneumothoraces (PTXs) from radiographic controls, including normals, bullous disease, and resolved PTXs.

METHOD AND MATERIALS

644 de-identified HIPAA compliant frontal view chest radiographs (CXRs) were obtained, consisting of large PTX (311/644, 48.3%) and radiographic controls (333/644, 51.7%). Images were verified by 2 board certified radiologists, using British Thoracic Society guidelines for classifying PTXs (>2cm depth from chest wall). Controls were CXRs consisting of extensive bullous disease (n=119), resolved PTXs (n=102), and normals (n=108). Three DCNN architectures were assessed-ResNet-34, Inception V1 and AlexNet-using two frameworks (Torch and Caffe), using pre-trained (from ImageNet) and untrained networks. Data-augmentation was used to increase the training dataset size 48-fold, including quadrilateral rotations, translation, shearing, and contrast-enhancement. Images were split into training (480, 74.5%), validation (64/644, 10%), and test (100/644, 15.5%). Receiver operating characteristic (ROC), area-under-the-curves (AUC) on the test data, and ensembles of the algorithms were performed. Statistical differences among the AUCs were obtained. $P < 0.05$ was considered statistically significant.

RESULTS

The best performing algorithm had an AUC of 0.96 (95% CI: 0.92-1.00), sensitivity 94.0%, and specificity 88.0% for distinguishing

PTXs from controls, which was an ensemble of 6 different algorithms, consisting of pretrained and untrained networks. The model was perfectly accurate in distinguishing normal radiographs from large PTXs (100%). However, false positives included 2 with bullous disease, and 4 with resolved PTXs.

CONCLUSION

Deep convolutional neural networks identified most PTXs with a sensitivity of 94%, and were perfectly accurate (100%) in identifying normal radiographs as not having a large PTX. However, specificity was reduced in differentiating PTX from potential mimics such as those with bullous disease, as well as resolved PTXs with chest tubes and support lines. More training data and other deep learning architectures may improve these results.

CLINICAL RELEVANCE/APPLICATION

Automated detection of large pneumothoraces using deep convolutional neural networks may reduce time to identification and reporting of such critical results.

RSNA 2017 Explore. Invent. Transform.
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November 26 to December 1
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SSA13

Science Session with Keynote: Molecular Imaging (Neuroinflammation, Brain Injury and Glioma)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S504CD

ER MR MI NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

Peter Herscovitch, MD, Bethesda, MD (*Moderator*) Nothing to Disclose
Alexander Drzezga, MD, Cologne, Germany (*Moderator*) Consultant, Siemens AG; Consultant, Bayer AG; Consultant, General Electric Company; Consultant, Eli Lilly and Company; Consultant, The Piramal Group; Speakers Bureau, Siemens AG; Speakers Bureau, Bayer AG; Speakers Bureau, General Electric Company; Speakers Bureau, Eli Lilly and Company; Speakers Bureau, The Piramal Group

Sub-Events

SSA13-01 Molecular Imaging Keynote Speaker: Imaging of Neuroinflammation

Sunday, Nov. 26 10:45AM - 10:55AM Room: S504CD

Participants
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SSA13-02 Neuroinflammation in Acute Hepatic Encephalopathy Rats: Imaging and Therapeutic Effectiveness Evaluation Using 11C-PK11195 and 18F-DPA-714 Micro-Positron Emission Tomography

Sunday, Nov. 26 10:55AM - 11:05AM Room: S504CD

Participants
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PURPOSE

Neuroinflammation is important in hepatic encephalopathy (HE). 11C-PK11195 is most common positron emission tomography (PET) molecular probe of neuroinflammation targeted to translocator protein (TSPO). 18F-DPA-714, a new radiotracer of TSPO, has not been used in research of neuroinflamation in acute hepatic encephalopathy (AHE). The aim of this study was to compare two radiotracers, 11C-PK11195 and 18F-DPA-714, as neuroinflammation agents for imaging of AHE rat model and using the new radiotracer 18F-DPA-714 imaging to observe therapeutic effectiveness treatment to neuroinflammation in AHE.

METHOD AND MATERIALS

Firstly, comparative study of 11C-PK1195 and 18F-DPA-714 PET were performed to AHE rats induced by thioacetamide. Twenty-four rats were divided into control (n=12) and AHE group (n=12), two radiotracers PET imaging (n=6 for each) was performed in each group, respectively. Uptake values of the whole brain between two groups were compared. Then, the optimized tracer were used to monitor anti-neuroinflammation effects of AHE. Forty-six rats were divided into four groups: [normal saline (NS) group (n=13), minocycline (MINO) group (n=11), dexamethasone (DEXA) group (n=11), MINO+DEXA group (n=11)]. 18F-DPA-714 PET was performed and the uptake values were calculated. The rotarod test, biochemical indexes and histopathological examination were quantitatively measured and compared.

RESULTS

AHE rats showed reduced motor ability, higher ammonia levels and liver function indexes and unchanged inflammatory factors compared with control group. Both 11C-PK11195 and 18F-DPA-714 PET can detect neuroinflammation of AHE rats. Behavioral studies showed MINO or/and DEXA improved AHE rats' motor ability, however, no differences were found for liver function and inflammatory markers among four groups. The average uptake values of whole brain and multiple brain areas in the MINO+DEXA group were lower than other groups, which was demonstrated by CD11b stains of microglia.

CONCLUSION

Both 11C-PK11195 and 18F-DPA-714 PET can detect neuroinflammation of AHE models, while the combined use of minocycline and dexamethasone can effectively inhibit neuroinflammation of AHE rats, which can be sensitively monitored by 18F-DPA-714 PET.

CLINICAL RELEVANCE/APPLICATION

Both 11C-PK11195 and 18F-DPA-714 PET might detect neuroinflammation of AHE models, and the treatment effect could be sensitively monitored by 18F-DPA-714 PET.

SSA13-03 Comparison Study of Radiogenomics Association and Prognostic Value Between MR Dynamic Susceptibility Contrast Perfusion Weighted Imaging and Diffusion Imaging in Patients with Newly Diagnosed Glioblastoma

Sunday, Nov. 26 11:05AM - 11:15AM Room: S504CD

Participants
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PURPOSE

MR DSC-PWI and DWI are advanced imaging techniques investigating glioblastoma hemodynamic and tumor cellularity abnormality in vivo. The purpose of this study is to evaluate and compare the association between genomic biomarkers and imaging parameters derived from MR DSC-PWI and DWI, and their prognostic value in predicting overall survival time (OS) in patients with newly diagnosed glioblastomas.

METHOD AND MATERIALS

Forty-one cases (mean age is 62.32±12.09) with new pathology confirmed glioblastomas were enrolled in this study. The mean, maximal relative cerebral blood volume (rCBV) ratio, mean apparent diffusion coefficient (ADC) and minimal ADC of the enhancing tumor (rCBVmean, rCBVmax, ADC mean and ADCmin), maximal rCBV ratio and minimal ADC of peri-enhancing tumor area (rCBVperi-tumor and ADCperi-tumor) were measured. The association between imaging parameters and Ki-67 labelling index, isocitrate dehydrogenase (IDH), mammalian target of rapamycin (mTOR), and EGFR was assessed, the Cox regression was used to evaluate their implication on OS.

RESULTS

There were 40 cases without IDH mutation, and there was no significant between ADC parameters and genomic biomarkers ($p>0.05$). In contrast, the rCBVmax had significant association with mTOR, ($p=0.047$), the rCBVperi-tumor was significantly associated with mTOR after adjustment of gender and EGFR. The Cox regression analysis showed that rCBVperi-tumor and age were the two strongest predictors of OS (hazard ratio= 1.29 and 1.063; $p=0.003$ and 0.005 respectively). The rCBVperi-tumor had better area under the curve than other imaging parameters and genomic biomarkers in ROC analysis, combination of rCBVperi-tumor and age improved the predication of OS with specificity of 78.9% and sensitivity of 81.8%.

CONCLUSION

This comparison study showed significant radiogenomics association between quantitative rCBV parameters and mTOR-EGFR pathway biomarkers, and rCBVperi-tumor had better prognostic value than genomic biomarkers and ADC parameters, which may suggest the tumor angiogenesis is moderated by mTOR-EGFR pathway plays more important role in tumor progression in patients with primary glioblastoma, and the genomics mechanism related with tumor cellularity changes may be more complicated.

CLINICAL RELEVANCE/APPLICATION

This study showed that rCBVperi-tumor had better prognostic value than genomic biomarkers alone, these radiogenomics findings will be useful in developing new target therapy.

SSA13-04 Roles of Elevated 20-HETE in the Breakdown of Blood Brain Barrier and the Severity of Brain Edema in Experimental Traumatic Brain Injury

Sunday, Nov. 26 11:15AM - 11:25AM Room: S504CD

Participants
Liyan Lu, Nanjing, Christmas Island (*Presenter*) Nothing to Disclose

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PURPOSE

Breakdown of the blood brain barrier (BBB) is a secondary injury following traumatic brain injury (TBI) and can lead to the development of brain edema. However, the factors that contribute to the disruption of the BBB and increase the severity of brain edema in TBI remain to be elucidated. The inhibition of 20-hydroxyeicosatetraenoic acid (20-HETE) synthesis by HET0016 has been suggested as a strategy to decrease brain edema. The present study aimed to investigate whether the elevated production of 20-HETE in cerebral tissue may contribute to BBB breakdown and increase the severity of brain edema in rats with TBI.

METHOD AND MATERIALS

BBB permeability was quantified using dynamic contrast-enhanced magnetic resonance imaging and brain edema was measured according to brain water content. Superoxide production in injured tissue was also assessed. Liquid chromatography-mass spectrometry was used to evaluate 20-HETE production in injured tissue. Western blot analysis was used to assess the expression of occludin, zonula occludens (ZO)-1, matrix metalloproteinase (MMP)-9, and proteins of the c-Jun N-terminal kinase (JNK) pathway.

RESULTS

A total of 3, 24 and 72 h following the induction of TBI, 20-HETE levels, BBB permeability and brain edema were identified to be increased, accompanied by an increase in superoxide production. Conversely, superoxide dismutase levels, in addition to the total antioxidative capability were decreased. In addition, the expression of MMP-9 and proteins of the JNK pathway was upregulated, whereas the expression of occludin and ZO-1 was observed to be suppressed. These results suggested that 20-HETE may aggravate BBB disruption following TBI, via enhancing the expression of MMP-9 and tight junction proteins. Furthermore, oxidative

stress and the JNK signaling pathway may be involved in BBB dysregulation.

CONCLUSION

In conclusion, the results of the present demonstrated that the production of 20-HETE was increased in cerebral tissue following traumatic injury, thus suggesting that it may contribute to the compromise of BBB integrity and the development of brain edema.

CLINICAL RELEVANCE/APPLICATION

This study was to explore the mechanism for the compromise of blood brain barrier integrity and the development of brain edema following traumatic brain injury. Furthermore, clinically, we could find another reason and tool to solve the problem of disruption of blood brain barrier afer traumatic brain injury.

SSA13-05 Multimodal PET and MR Imaging With Pathologic Confirmation Detects Axonal and Synaptic Preservation After Paclitaxel Administration for Repeat Concussive Brain Injury in Mice

Sunday, Nov. 26 11:25AM - 11:35AM Room: S504CD

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PURPOSE

PET and MR imaging have been proposed as biomarkers to evaluate repeat concussive brain injury (rcTBI) clinically. In this study, we hypothesized that imaging could be used in mice to detect axonal and synaptic injury from rcTBI as well as response to therapeutic intervention by paclitaxel.

METHOD AND MATERIALS

Mice received repeat concussive controlled cortical impact (rcCCI) one impact/day for five days (n=15) or sham CCI (n=8). Intranasal PTX (0.6 mg/kg; n=6) or saline (SAL) (n=9) was administered only after first CCI. Diffusion tensor imaging (DTI) was acquired on 14T as a 4 shot EPI, TR/TE=500/16.482ms, 30 diff directions, Max bval=6477.26849710899 s/mm2. Fractional anisotropy (FA) was compared using manual ROIs as well as FSL tract-based spatial statistics (TBSS). Glucose metabolism was assed via SUV corrected 18F-flurodeoxyglucose (FDG) PET imaging as a biomarker for synaptic activity. At 45 days, brains were evaluated for pathologic evidence of axonal injury (silver stain) and synaptic loss (PSD-95) in the external capsule and hippocampus respectively.

RESULTS

FA in the external capsule was decreased in rcTBI by 17% compared to SHAM (0.21±0.01 vs 0.25±0.01, p<=0.05) and extensive areas of white matter injury were seen by TBSS. However, PTX-rcCCI was not significantly different from SHAM or SAL-rcCCI with either analysis. With silver stain, axonal degeneration was seen in cortical white matter of the external capsule in 5/6 SAL-rcCCI but not PTX-treated (n=0/5). A single, dystrophic axon was observed in 1/8 shams. The SAL-rcCCI showed significantly decreased brain FDG uptake, which was "normalized" in PTX mice. Whole brain SUVs, were 120.5±30.1, 90.3±18.7 and 129.2±23.0, for SHAM, SAL- and PTX-rcCCI respectively, p<=0.05. In SAL-rcCCI, hippocampal PSD-95 immunofluorescence was reduced compared to both SHAM and PTX.

CONCLUSION

Both DTI and FDG-PET detected brain alterations in white matter structure and glucose metabolism from repeat concussive injury. However, only FDG-PET confirmed that PTX resulted in improvement when pathology indicated both synaptic loss AND axonal injury were prevented with PTX. DTI may not be sensitive enough or may have more inherent variability to detect treatment-related benefit in rcTBI. Further research is needed to distinguish these factors.

CLINICAL RELEVANCE/APPLICATION

Establishment of brain imaging biomarkers is of critical importance to research and therapeutic development for traumatic brain injury.

SSA13-07 Evolution of Diffusion in Hematoma and Perihematoma after Experimental Intracerebral Hemorrhage by 7.0 T DTI

Sunday, Nov. 26 11:45AM - 11:55AM Room: S504CD

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To characterize experimental hematoma and perihematoma using diffusion tensor imaging (DTI) and compare the feature of diffusion with that of histology after intracerebral hemorrhage (ICH).

METHOD AND MATERIALS

Twenty-nine male SD rats injected with 40 μL autologous blood in the right basal ganglia underwent 7.0 T MR with T2WI (additional day 0, D0) and DTI sequences at days 1 (D1), 3 (D3), 7 (D7), 14 (D14), 21 (D21), and 28 (D28). HE, Iba1, and glial fibrillary acidic protein staining was performed after brain fixation. Hematoma volume at D0 was measured by T2WI images. Mean diffusivity (MD), axial diffusivity, and radial diffusivity were measured by DTI images. Abnormal MD volumes were delineated manually by MD maps.

RESULTS

The mean hematoma volume was 14.78 μL at D0. The main patterns of diffusivity changes in the ipsilateral basal ganglia after ICH on MD maps visually included relative central hyper-value zone (rCEVZ; MD at D1: 9.54 ± 2.57 x 10-4mm2/s), relative hypo-value zone (rOVZ; MD at D1: 6.94 ± 0.96 x 10-4mm2/s), and relative peripheral hyper-value zone (rPEVZ; MD at D1: 9.61 ± 0.59 x 10-4mm2/s). The rCEVZ corresponded to the area with not only heterogeneous erythrocytes and serum at D1, D3, and D7, but also necrosis of brain parenchyma at D1 and D3. The rOVZ corresponded to the area with vasogenic and cytotoxic edema at D1, D3 and D7, neutrophil accumulation at D3 and D7, microglia proliferation from D3 to D28, and astrocyte proliferation from D7 to D28. The rPEVZ corresponded mainly to the area with cytotoxic and vasogenic edema at D1, D3 and D7, also with glial cell proliferation from D3 to D28. Volumes of abnormal diffusion at D1 and D3 were significantly greater than the hematoma volume at D0 (both $p < 0.001$). The rCEVZ volumes at D1, D3, and D7 were significantly lower than hematoma volume at D0 (all $p < 0.001$). The rOVZ and rPEVZ volumes peaked at D1 and D3, respectively.

CONCLUSION

The results imply diffusion changes in hematoma and perihematoma after ICH involve complex pathological alterations including blood components, cytotoxic and vasogenic edema, and cellular accumulation and proliferation.

CLINICAL RELEVANCE/APPLICATION

This research exhibit evolution of diffusion in hematoma and perihematoma with histological basis, which is useful to explain the diffusion changes in patients after intracerebral hemorrhage.

SSA13-08 Amide Proton Transfer-Weighted MRI Signal As a Novel Imaging Marker for Prediction of MGMT Promoter Methylation Status in Glioblastoma

Sunday, Nov. 26 11:55AM - 12:05PM Room: S504CD

Participants
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PURPOSE

Methylated O6-methylguanine-DNA methyltransferase (MGMT) promoter fosters longer survival in patients with Glioblastoma (GBM) who receive alkylating agents due to the reduced counteraction of alkylating chemotherapy. However, the MGMT methylation status test primarily relies on the invasive surgical procedure. Amide proton transfer-weighted (APTW) imaging is a novel molecular MRI technique that gives contrast mainly based on endogenous cellular proteins. This study aimed to investigate whether MGMT methylation status in GBM is correlated to APTW imaging features.

METHOD AND MATERIALS

Patients with suspected GBM underwent routine and APTW MR sequences at 3T prior to surgery. The MGMT methylation status was assessed with immunohistochemical stain and verified by methylation-specific polymerase chain reaction. APTW images were calculated using MTRasym(3.5ppm). The maximum and minimum (APTWmax and APTWmin), the average (APTWave), and the heterogeneity (APTWhet = APTWmax - APTWmin) of APTW signal intensities were obtained using the contralateral normal brain area as normalization.

RESULTS

Eleven patients with GBM were confirmed as MGMT promoter methylated, and the remaining seven patients were confirmed as unmethylated. Most GBMs with unmethylated MGMT demonstrated heterogeneous, strong hyperintensity on APTW images (A), while most GBMs with methylated MGMT showed heterogeneous, moderate APTW hyperintensity (B). The unmethylated MGMT group has significantly higher APTWmax (3.46 ± 0.49% vs. 2.67 ± 0.59%); APTWave (2.90 ± 0.37% vs. 2.28 ± 0.47%); APTWmin (2.31 ± 0.27% vs. 1.90 ± 0.42%); and APTWhet (1.15 ± 0.33% vs. 0.77 ± 0.23%) than the methylated MGMT group, all $p < 0.05$ (C). APTWmax and APTWave had the highest area under the curve (0.857) and accuracy (90.4 %) in differentiating GBMs with methylated MGMT from unmethylated MGMT GBMs (D).

CONCLUSION

Our early results suggest that GBMs with different MGMT methylation statuses are associated with distinguishable APTW imaging

features. The APTW signal is a valuable imaging biomarker for identifying MGMT methylation status of GBMs, which is of paramount importance for the management of alkylating agent chemotherapy.

CLINICAL RELEVANCE/APPLICATION

Preoperative APTW imaging signal has the potential to non-invasively predict the MGMT promoter methylation status in patients with GBM. APTW signal may serve as a surrogate imaging maker for identifying the MGMT promoter methylation status preoperatively.

SSA13-09 Lipopolysaccharide Endotoxemia Results in Secondary Neuroinflammation and Deposition of Amyloid Beta and Phosphorylated Tau in the Rat

Sunday, Nov. 26 12:05PM - 12:15PM Room: S504CD

Participants
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PURPOSE

Amyloid-Beta (AB) plaque deposition occurs in Alzheimer's disease as well as aging and other neurodegenerative disorders. Soluble AB may increase in response to neuroinflammation. Sepsis results in short and long term neurocognitive impairment in many patients. The objective was to determine whether acute systemic endotoxemia results in secondary neuroinflammation with consequent AB plaque and p-tau deposition in the brain.

METHOD AND MATERIALS

Male Sprague Dawley rats received an IP injection of 10 mg/kg of E. Coli lipopolysaccharide (LPS) to mimic sepsis. IL-1B, IL-6 and TNFA were measured by ELISA in whole brain homogenates of LPS-injected and control rats. Soluble AB and p-tau proteins in brain homogenates were measured by immunoblotting. Cortical AB plaques were quantified by immunostaining and morphologically characterized by confocal microscopy. Microglial density was quantified by Iba1 immunostaining. At 72 h post LPS administration, rats were injected intravenously with 18F-flutemetamol and the resultant brain uptake was quantified by digital autoradiography of cryomicrotome slices.

RESULTS

Endotoxemia resulted in increased cytokines in the brain, particularly IL-1B (7.8 fold increase over controls at 24h, $p < .0001$). Cortical microglial density was 1.9-fold higher LPS-injected rats than controls ($p < .001$). Compared to controls, systemic LPS produced significant brain increases of soluble AB (1.98-fold increase, $p < .01$) and p-tau (2-fold increase, $p < .01$) and a progressive accumulation of AB aggregates, which were morphologically similar to diffuse plaques. There was no significant difference in uptake of 18F-flutemetamol in the cerebral white matter (corpus callosum) in the brains of LPS-treated vs. control rats. The cerebral cortical activity was 2.02 fold higher in LPS than control rats ($p < .01$), a difference that was visually appreciable.

CONCLUSION

LPS endotoxemia causes secondary neuroinflammation and elevations in cytokines, soluble AB, p-tau and AB plaques in the brain, and cortical deposition of 18F-flutametamol. Whether these findings eventually resolve or are associated with neurocognitive impairment are as of yet unknown.

CLINICAL RELEVANCE/APPLICATION

18F flutemetamol PET could provide a mechanism to study the effects of systemic inflammatory conditions on the brain, the pathogenesis of which may involve the accumulation of AB.

SSA14

Science Session with Keynote: Musculoskeletal (Lower Extremity)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S406A

CT MK MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Corrie M. Yablon, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose
Karen C. Chen, MD, Providence, RI (*Moderator*) Nothing to Disclose

Sub-Events

SSA14-01 Musculoskeletal Keynote Speaker: Update on Lower Extremity Imaging

Sunday, Nov. 26 10:45AM - 10:55AM Room: S406A

Participants
Laura W. Bancroft, MD, Orlando, FL (*Presenter*) Author with royalties, Wolters Kluwer nv

SSA14-02 CT Texture Analysis of Acetabular Subchondral Bone Can Discriminate Between Normal and Cam Positive Hips in Femoroacetubular Impingement

Sunday, Nov. 26 10:55AM - 11:05AM Room: S406A

Participants
Taryn Hodgdon, MD, Ottawa, ON (*Presenter*) Nothing to Disclose
Rebecca Thornhill, PhD, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose
Paul E. Beaule, MD, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose
Kawan S. Rakhra, MD, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Cam-type femoroacetabular impingement (FAI) has been associated with early degenerative change of the hip. The purpose of this study was to assess whether texture analysis could determine microscopic changes in the architecture of acetabular subchondral bone prior to the development of macroscopic structural damage on CT.

METHOD AND MATERIALS

This was an IRB-approved, retrospective case-control study analyzing CT images obtained in subjects with and without cam-type deformities of the proximal femur. Subjects with cam deformity were further subdivided into asymptomatic cam and symptomatic cam-FAI groups. There were a total of 68 patients: 19 controls, 26 asymptomatic cam, and 23 symptomatic cam-FAI. All subjects underwent CT scan of the pelvis. The subchondral bone of the entire acetabulum was contoured manually as a volume of interest (VOI) on the sagittal images for each patient using ImageJ ®. 3D histogram texture features (mean, variance, skewness and kurtosis) were evaluated for each patient using MaZda software. Groupwise differences (controls, asymptomatic cam, and symptomatic cam patients) were initially investigated for each feature using Kruskal-Wallis tests. Subsequently, differences between controls and either asymptomatic or symptomatic cam deformities were assessed using Mann-Whitney U tests with post-hoc Bonferroni correction for multiple comparisons.

RESULTS

Both asymptomatic and symptomatic cam-FAI hips demonstrated significantly higher values of texture variance compared to normal controls (p=0.002, p=0.003), but significantly lower values of skewness (p=0.005, p=0.002) and kurtosis (p=0.003, p=0.004) compared to normal controls. There were no differences in texture profile between asymptomatic cam and symptomatic cam-FAI hips.

CONCLUSION

Hips with cam deformities demonstrated increased variance, decreased skewness, and decreased kurtosis compared to normal control subjects. These findings suggest that 3D histogram texture features extracted from CT images can detect differences in subchondral bone architecture between controls and those with cam deformities, regardless of the patient's symptom status.

CLINICAL RELEVANCE/APPLICATION

Changes in texture profile of asymptomatic cam hips is as pronounced as that of symptomatic cam-FAI hips. This may facilitate identification of patients at risk of developing hip dysfunction due to altered biomechanics conferred by the bone changes.

SSA14-03 Variability of MRI Reporting in Proximal Hamstring Avulsion Injury

Sunday, Nov. 26 11:05AM - 11:15AM Room: S406A

Participants
Erin F. Alaia, MD, New York, NY (*Presenter*) Nothing to Disclose
Soterios Gyftopoulos, MD,MSc, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Michael Alaia, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Quantification of tendon retraction is paramount in management of proximal hamstring avulsions, impacting the decision to perform surgery and the type of incision used. However, variability in the measurement landmark used on the broad ischial tuberosity origin, and difficulty in locating the proximal tendon stump may lead to significant variability in measured retraction. The purpose of our study was to survey musculoskeletal (MSK) radiologists and orthopedic surgeons on the ischial tuberosity landmark used in hamstring avulsion, and the clinical impact of MRI measurements and report content.

METHOD AND MATERIALS

Two survey instruments were created. One survey was sent by email to members of the Society of Skeletal Radiology (SSR), querying the preferred ischial tuberosity landmark, perceived difficulties in quantifying retraction, and the impact of the radiology report on clinical decision making. A similar survey, with added questions on the impact of imaging findings, was posted onto the American Orthopaedic Society for Sports Medicine (AOSSM) website and sent by email to orthopedic colleagues.

RESULTS

A total of 218 MSK radiologists (SSR members), and 33 orthopedic surgeons completed the survey. The conjoint tendon origin was the most common proximal landmark used for both orthopedic surgeons (66.7%) and radiologists (47%) in complete hamstring avulsion. For 71% of orthopedic surgeons, the radiology report impacts the decision to perform surgery, and for 45%, the report impacts the incision used. 36% of orthopedic surgeons report overestimation of measurements in radiology reports due to differences in landmarks used for measurement, while 27% report underestimation. 43% of radiologists report difficulty in determining location of the retracted tendon, and 31% report difficulty determining the ischial tuberosity landmark for measurement.

CONCLUSION

Differences in the ischial tuberosity landmark used, and difficulty in locating the proximal tendon stump may lead to variability in measured tendon retraction in proximal hamstring avulsion, and may alter the decision to perform study and the type of incision used.

CLINICAL RELEVANCE/APPLICATION

Differences in the ischial tuberosity landmark used, and difficulty in locating the proximal tendon stump may lead to variability in measured tendon retraction in cases of proximal hamstring avulsion, and may significantly impact surgical management.

SSA14-04 Does Labral Size and Tear Pattern Differ Between FAI Patients with Femoral Retrotorsion Compare to Increased Femoral Antetorsion?

Sunday, Nov. 26 11:15AM - 11:25AM Room: S406A

Participants
Inga Todorski, Bern, Switzerland (*Presenter*) Nothing to Disclose
Florian Schmaranzer, Bern, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Till Lerch, Bern, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Simon D. Steppacher, MD, Bern, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Klaus A. Siebenrock, MD, PhD, Bern, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Moritz Tannast, MD, Bern, Switzerland (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

In patients with femoroacetabular impingment (FAI) femoral retrotorsion and increased femoral antetorsion (FT) contribute to an unknown degree to the bony conflict. Hence the role of de-/rotational osteotomies is yet to be defined in FAI patients. In hip dysplasia, cam and pincer FAI the labrum shows distinct tear patterns. By contrast, the impact of femoral retrotorsion and increased FT on labral tear patterns and labral size is currently unclear. Our aim was to compare (1) labral size and (2) tear pattern between hips with femoral retrotorsion and increased FT.

METHOD AND MATERIALS

After IRB approval for this retrospective study the institutional MR database (2011-2016; 620 hips) was reviewed for direct MR arthrographies (3.0T) in FAI hips with femoral retrotorsion (30° FT, 71 hips). Groups were comparable for age, acetabular version and coverage (LCE between 22° and 39°). Additionally to the multiplanar standard protocol, axial images including the distal femoral condyles for measurement of FT and 2D radial PD-w images using the femoral neck axis as center of rotation were obtained. On each half o'clock position (30° intervals per slide gap) the labral cross sectional area (CSA, mmSquared) was measured circumferentially with OSIRIX® software. Labrum tear pattern was described as follows: intact, degeneration, intersubstance tear, intrasubstance tear. CSA was compared with unpaired t-tests and labrum tear pattern was compared with chi-square test between the groups ($p<0.05$).

RESULTS

(1) Labral CSA was significantly decreased from 7.30 to 4.30 o'clock in hips with femoral retrotorsion compared to hips with increased FT ($p<0.05$).(2) Prevalence of intrasubstance tears was significantly higher anteriorly (1.30 to 3 o'clock position; $p<0.05$) in hips with increased FT compared to hips with femoral retrotorsion.

CONCLUSION

Labral size and tear pattern differ between FAI patients with femoral retrotorsion compared to increased FT. A hypotrophic labrum in hips with femoral retrotorsion may reflect an anterior impingement. Higher prevalence of anterior intrasubstance labrum tears

could result from instability in hips with increased FT.

CLINICAL RELEVANCE/APPLICATION

Systematic assessment of labrum size and tear pattern in patients with FAI can help to define the role of additional femoral de-/rotational osteotomies in FAI patients.

SSA14-05 Comparison of a Fast 5-minute Knee MRI Protocol with a Standard Knee MRI Protocol: A Multi-institutional Multireader Study

Sunday, Nov. 26 11:25AM - 11:35AM Room: S406A

Participants
Erin F. Alaia, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

The purpose of this study was to compare the diagnostic performance of a 5-minute knee MRI protocol with parallel imaging to that of a standard knee MRI protocol.

METHOD AND MATERIALS

100 3T MRIs of 100 patients (mean age, 38.8 years) and 50 1.5T MRIs of 46 patients (mean age, 46.4 years), consisting of 5 fast multiplanar 2D FSE sequences using parallel imaging and 5 standard sequences, performed at 2 academic centers from January 2015 to July 2016 were retrospectively reviewed by 4 MSK radiologists. Agreement between fast and standard MRI readings (interprotocol agreement) and agreement of standard MRI readings (intraprotocol agreement) when evaluating menisci, ligaments, cartilage and bone was compared for interchangeability. Additional comparisons between fast and standard MRI with regards to frequency of major findings and sensitivity and specificity in 51 patients who underwent surgery were tested for significant differences.

RESULTS

Interreader agreement with fast MRI was very similar to interreader agreement with standard MRI (83.0-99.5% across structures) with no excess disagreement (<=1.1%; 95% CI, -4.2% to 3.8% across structures). Frequency of major findings (1.1-22.4% across structures) reported on fast and standard MRI were not significantly different ($p >= 0.215$ across structures) except more ACL tears were reported on fast MRI ($p=0.021$) and more cartilage defects were reported on standard MRI ($p<0.001$). Sensitivities (59-100% across structures) and specificities (73-99% across structures) of fast and standard MRI were not significantly different for meniscal and ligament tears (95% CI for difference, -0.08 to 0.08). For cartilage defects, fast MRI was slightly less sensitive (95% CI for difference, -0.125 to -0.01) but slightly more specific (95% CI for difference, 0.01 to 0.5) than standard MRI.

CONCLUSION

A fast 5-minute knee MRI using parallel imaging is interchangeable with and has similar accuracy to a standard knee MRI for evaluating internal derangement of the knee.

CLINICAL RELEVANCE/APPLICATION

A fast 5-minute knee MRI would be helpful to improve efficiency and patient throughput when MRI availability is limited and increase patient comfort and exam tolerability in patients with claustrophobia and pain.

SSA14-06 Does Cartilage Repair Surgery Prevent Progression of Knee Degeneration? A Quantitative Control-matched MRI Study

Sunday, Nov. 26 11:35AM - 11:45AM Room: S406A

Participants
Pia M. Jungmann, MD, Augsburg, Germany (*Abstract Co-Author*) Nothing to Disclose
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Thomas M. Link, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Research Grant, General Electric Company; Research Consultant, General Electric Company; Research Consultant, InSightec Ltd; Research Grant, InSightec Ltd; Royalties, Springer Nature; Consultant, Springer Nature; Research Consultant, Pfizer Inc;
Alexandra S. Gersing, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Jan Neumann, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

PURPOSE

To assess, whether cartilage repair surgery (CR) for treatment of focal cartilage defects at the knee prevents progression of degenerative changes on MRI in a longitudinal follow-up.

METHOD AND MATERIALS

A total of N=32 individuals with focal cartilage defects at the knee received baseline and 6-year follow-up MRI studies. Preoperative MRIs of n=16 individuals (12 male, 4 female) who received CR surgery were matched with n=16 baseline MRIs of individuals from the

Osteoarthritis Initiative (OAI) with initially morphologically identical cartilage defects (control group without surgery; 6 male, 6 female). Morphological knee abnormalities were assessed using Whole-Organ-Magnetic-Resonance-Imaging-Scores (WORMS), AMADEUS scores and MOCART scores. Mean values, mean differences and standard deviations (SD), paired t-tests and multiple regression models were used for statistical analyses.

RESULTS

In both groups, focal cartilage defects were found at the femoral condyle in 8/16 cases and at the patella in 8/16 cases. Total WORMS scores (mean difference±SD, -4.7±10.2, P=0.085) and cartilage scores for the affected knee compartment (-0.3±1.5, P=0.378) were not significantly different between the two groups at baseline. The increase of total WORMS scores during identical follow-up times (CR patients: 5.7±2.3 years; OAI: 5.6±1.4 years) was significantly more severe in individuals that did not receive surgery (P<0.001). Cartilage defects at the affected (P<0.001) and opposing compartment (P=0.029) showed a more severe progression in the non-operated cohort (Figure 1). For patients that received CR, the mean preoperative AMADEUS score was 48.1±15.8 and the mean postoperative MOCART score was 77.5±18.9. In control subjects from the OAI, cartilage T2 relaxation times increased from 32.4±2.5ms at baseline to 34.5±2.3ms at follow-up (P=0.002).

CONCLUSION

Since patients with CR showed significantly less progression of cartilage defects and of degenerative MRI changes at the knee (WORMS scores) than an initially identical control cohort from the OAI in a 6 year follow-up, CR may prevent progression of early osteoarthritis.

CLINICAL RELEVANCE/APPLICATION

This MR imaging pair-matched study supports the assumption, that osteochondral transplantation prevents progression of cartilage defects and early osteoarthritis at the knee in a mid-term follow-up.

SSA14-07 Weight-Bearing Digital Tomosynthesis of Foot/Ankle Arthritis: Comparison to Radiography and Simulated Weight-Bearing Computed Tomography

Sunday, Nov. 26 11:45AM - 11:55AM Room: S406A

Participants
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Xue B. Cunningham, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Alan S. Leung, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Jennifer L. Favinger, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Daniel S. Hippe, MS, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company; Research Grant, Toshiba America Medical Systems

PURPOSE

Foot/ankle arthritis is common and debilitating. Weight-bearing radiography remains the gold standard in evaluating alignment, but overlapping bones or hardware limit evaluation for arthritic bony detail. We hypothesized that digital tomosynthesis (DTS) can provide reliable quantitative alignment values like radiography with its weight-bearing capability and good qualitative arthritic details like computed tomography (CT) with its plane-by-plane images.

METHOD AND MATERIALS

In this IRB-approved prospective study, adult patients with foot/ankle pain and arthritis referred for simulated weight-bearing CT were recruited to undergo weight-bearing radiography and DTS. Four readers independently evaluated radiography and DTS images in randomized orders for foot/ankle alignment and severity of osteoarthritis for each joint (e.g., joint space narrowing, osteophytes, subchondral cyst). Two readers performed consensus reading of CT. Radiography was considered the gold standard for foot alignment and CT for osteoarthritic details. Agreement between modalities was assessed using the intraclass correlation coefficient (ICC) (quantitative variables) and Cohen's kappa (qualitative variables).

RESULTS

46 patients (24 men; mean age 54 years) with a total of 91 ankles were included. Trauma (67%), osteoarthritis (52%), and congenital deformity (41%) were the most common prior conditions. All joints were less obscured when seen with DTS or CT (4-11%) when compared to radiography (14-34%, p<0.001). For quantitative measurements of foot alignment (Table 1), DTS had moderate to good agreement with radiography, which was significantly better than CT in most cases. For qualitative osteoarthritic details of the tibiotalar joint (when not obscured), agreement was moderate to good for most features, with kappa ranging from 0.47 to 0.62 between radiography and CT and from 0.48 and 0.63 between DTS and CT.

CONCLUSION

DTS leads to less obscuration of joints than radiography and provides reliable weight-bearing quantitative foot/ankle alignment values when compared to radiography and osteoarthritic bony details when compared to CT.

CLINICAL RELEVANCE/APPLICATION

Digital tomosynthesis allows for tomographic characterization of foot/ankle arthritis while weight-bearing with comparable details to CT with less cost and radiation.

SSA14-08 Intravoxel Incoherent Motion (IVIM) Imaging of Exercised Induced Hemodynamics Response in Achilles Tendon

Sunday, Nov. 26 11:55AM - 12:05PM Room: S406A

Participants
Xiang He, PhD, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose
Kenneth T. Wengler, MS, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose
Dharmesh Tank, MD, Stony Brook, NY (*Presenter*) Nothing to Disclose
Elaine S. Gould, MD, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose
Mark E. Schweitzer, MD, Stony Brook, NY (*Abstract Co-Author*) Consultant, MMI Munich Medical International GmbH; Data Safety

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Mingqian Huang, MD, Syosset, NY (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Achilles tendon (AT) microcirculation plays a crucial role in tendon degeneration and repair. Intravoxel incoherent motion (IVIM) MRI has been applied in skeletal muscle hemodynamics by exercise. However, the application of IVIM to tendons is challenged by the short T2/T2* (~7 ms) and long TE (~50-80 ms) typically required. In this study, we utilized a stimulated-echo based short TE (<20 ms) tendon diffusion protocol (ste-RESOLVE) to study hemodynamic response in the Achilles tendon following exercise in healthy subjects, to provide a springboard to aid in our understanding of the role of hypovascularity in tendinopathy.

METHOD AND MATERIALS

Seven healthy subjects were recruited for this IRB approved study. After baseline tendon IVIM imaging at magic angle, subjects were instructed to perform 5 minutes of standardized heel-raise exercises outside the scanner immediately prior to re-imaging. The tendon diffusion coefficient (D), pseudo-diffusion coefficient (D*), and perfusion fraction (fp) were calculated using standard bi-exponential fit. D*× fp was used as an indicator of blood flow, while fp was used as an indicator of blood volume.

RESULTS

The pre-exercise measured fp and D*x fp were 2.81±1.09% and 17.45±10.81 respectively. The post-exercise measured fp and D*x fp were 4.96±1.23% and 40.52±23.27 respectively. The relative increase in tendon blood volume and tendon perfusion was 87.11% and 227.41%, respectively.

CONCLUSION

This study evaluated the feasibility and robustness of a ste-RESOLVE-based IVIM protocol. We expect that our estimated IVM parameters in control subjects may serve as a baseline for subsequent studies on patients with clinical and subclinical Achilles tendinosis. We hope that this technique can now be used to monitor tendon healing and repair and assess the potential risk of rupture in diseased tendons.

CLINICAL RELEVANCE/APPLICATION

This study established the feasibility of using ste-RESOLVE IVIM protocol to measure exercise induced hemodynamics changes in Achilles tendon.

SSA14-09 Ankle Syndesmosis Measurements Using Four-Dimensional Computed Tomography: Correlation with Symptoms and Imaging Signs of Tibiotalar Osteoarthritis

Sunday, Nov. 26 12:05PM - 12:15PM Room: S406A

Awards
Student Travel Stipend Award

Participants
Nima Hafezi Nejad, MD, MPH, Baltimore, MD (*Presenter*) Nothing to Disclose
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Shadpour Demehri, MD, Baltimore, MD (*Abstract Co-Author*) Research support, General Electric Company; Research Grant, Carestream Health, Inc; Consultant, Toshiba Corporation;

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PURPOSE

Four-Dimensional CT (4DCT) can be used for the kinematic assessment of peripheral joints during active motion. Nevertheless, evidence regarding the use of 4DCT for the assessment of ankle pain and instability is limited. Our objective was to evaluate the correlation between CT-derived indices of ankle syndesmosis during active plantar-dorsiflexion motion and patient reported symptoms as well as imaging features of tibiotalar osteoarthritis (OA).

METHOD AND MATERIALS

This is an IRB approved HIPAA complaint, retrospective analysis of a group of prospectively recruited patients in our 4DCT study. Eight patients with chronic, unilateral signs and symptoms of ankle pain and instability referred for advanced imaging evaluation, were included in this study. Bilateral 4DCT was performed using a 320-row detector CT scanner (Aquilion one, Toshiba Medical Systems) during active motion from complete dorsiflexion to plantar flexion (0.5 sec. temporal resolution). Two previously defined indices of ankle syndesmosis were measured by a fellowship trained foot & ankle surgeon: 1.Syndesmotic Anterior Distance (SAD), 2.Syndesmotic Translation (ST). Tibiotalar OA was assessed using Kellgren-Lawrence (KL) grading. Reliability of the selected indices was confirmed in our previous study. Imaging examinations were interpreted by a musculoskeletal radiologist with 8 years of

experience.

RESULTS

There was a significant difference in the overall SAD measurements between asymptomatic (median centimeters (interquartile range): 0.37 (0.33 - 0.47)) and symptomatic (0.30 (0.26 - 0.38)) ankles. Unlike ST measurements (change in motion: -0.03 (-0.13 - 0.00) P:0.027), SAD measurements were not a function of ankle motion and tibiocalcaneal angle. Changes in SAD measurements from dorsiflexion to plantar flexion were significantly correlated with the tibiotalar OA severity, defined by KL grades (point biserial correlation coefficient: -0.688, P:0.003)

CONCLUSION

SAD does not change significantly during ankle dorsi/plantar flexion and is associated with the presence of symptoms and imaging features of osteoarthritis.

CLINICAL RELEVANCE/APPLICATION

Our study represents one of the very few kinematic assessments of ankle syndesmosis using 4DCT examination. Changes in SAD, but not ST measurements are independent of tibiocalcaneal angle. Increased changes in SAD during dorsiflexion and plantar flexion motion are correlated with clinical and imaging features of tibiotalar OA.

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SSA15

Musculoskeletal (Bone Marrow and Neoplasms)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S406B

BQ CT MR MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Jeffrey J. Peterson, MD, Neptune Beach, FL (*Moderator*) Nothing to Disclose
Matthew D. Bucknor, MD, San Francisco, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSA15-01 Comparison of Qualitative and Quantitative CT and MRI Parameters for Monitoring of Longitudinal Spine Involvement in Patients with Multiple Myeloma

Sunday, Nov. 26 10:45AM - 10:55AM Room: S406B

Participants
Christopher Kloth, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose
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Sebastian Werner, Tuebingen, Germany (*Presenter*) Nothing to Disclose
Katja Weisel, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose
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Konstantin Nikolaou, MD, Tuebingen, Germany (*Abstract Co-Author*) Speakers Bureau, Siemens AG; Speakers Bureau, Bracco Group; Speakers Bureau, Bayer AG
Marius Horger, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the diagnostic performance of CT-based quantification of skeletal changes using a dedicated post-processing subtraction tool by comparison with standard-CT reading and MRI for longitudinal disease monitoring in multiple myeloma.

METHOD AND MATERIALS

Included were 31 consecutive myeloma patients (17 male; mean age, 59.20 ± 8.08y) who underwent who underwent 154 repeated examinations consisting of whole-body MRI (n=76) and whole-body reduced-dose MDCT (n=78) at our institution between June 2013 and September 2016. Nonenhanced reduced-dose whole-body-CT was performed using thin-collimation. We classified response according to standard CT-reading into progression (new or enlarging osteolyses) vs. stable/ response (no change). Quantitative CT was performed on subtraction maps created for the entire axial skeleton. Results were classified into progressive disease (PD), stable (SD) and response (partial + complete, PR/CR). On MRI, bone marrow manifestations were evaluated by qualitative image analysis (number/size) on coronal T1w-TSE, T2*w and STIR. Standard-of-reference was the hematological laboratory (M-gradient).

RESULTS

Hematological response categories were: CR(n=14/47, 29.7%), PR(2/47, 4.2%), SD(16/47, 34.0%) vs. PD(15/47/29.9 %). Standard-CT classification yielded PD (25.5%) and SD/PR/CR (74.5%) whereas quantitative CT classified 12 (25.5%) PD, 26 (55.3%) SD and 9 (19.2%) PR/CR. Qualitative MRI classified 14 (29.7%) PD, 16 (34%) SD and 17 (36.3%) PR/CR. Quantitative MRI measured in focal lesions yielded no significant change in T1/T2/T2* or ADC signal intensity between baseline and FU whereas at non-focally involved skeletal sites, signal intensity changes on T2w/T2* and ADC reached significance only in stable disease ($p<0.001$). Changes in mean/min/max HU values in bone on CT did not correlate significantly with changes in measured MRI values.

CONCLUSION

Imaging response monitoring using CT can be improved by using quantitative parameters for evaluation of focal lesions whereas for MRI only qualitative parameters prove reliable.

CLINICAL RELEVANCE/APPLICATION

The use of longitudinal bone subtraction maps for therapy response monitoring in MBD improves diagnostic accuracy by focusing the reader's attention solely on the bone changes that have occurred within the control interval, ignoring all other myriads of bone lesions staying unchanged.

SSA15-02 Quantification of Bone Marrow Adipose Tissue Using Off-the-shelf Gradient Echo MR Imaging

Sunday, Nov. 26 10:55AM - 11:05AM Room: S406B

Participants
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PURPOSE

To determine the feasibility of fast and widely available, Quantitative Gradient-Echo (QGRE) MRI for quantification of bone marrow adipose tissue (MAT) using, state of the art, SE-Dixon Quantitative Chemical Shift Imaging (QCSI) as a reference standard. Subsequently we aimed to determine age and gender specific differences in marrow fat fractions (FF) of the spine and femur.

METHOD AND MATERIALS

L3-5 FF of 11 patients with Gaucher disease (GD) were measured using both a QGRE sequence (scan time 1 minute) and our SE-Dixon QCSI sequence (scan time 21 minutes), on the same day, on a Siemens 1.5 Tesla MRI-scanner (Avanto). QGRE FF of the spine (C1-L5) and both femora were measured in 40 healthy subjects (median age: 51 years; range: 23-76; 26 males). Regions of interest covering the individual vertebral bodies were drawn on sagittal images. Coronal images of femora were acquired and divided into 3 regions of interest: proximal metaphysis, diaphysis and distal metaphysis. During post processing a multi peak fat model was used for fitting.

RESULTS

In GD, L3-5 QCSI and QGRE MRI, FF showed good agreement (intra class correlation coefficient L3-5: 0.80 (95% CI 0.32-0.95, $p<0.001$). In healthy subjects, QGRE spinal FF increased from cranial to caudal: mean FF(±SD): 36.1% (±9.9), 37.9% (±8.1) and 43.4% (±9.5) for the cervical, thoracic and lumbar spine respectively (linear mixed model: $p<0.001$). QGRE median femoral FF increased from proximal to distal: 83.8% (interquartile range: 76.6-88.0%), 89.7% (80.8-94.7%) and 95.0% (93.7-95.7%) for the proximal metaphysis, diaphysis and distal metaphysis respectively (Friedman test: $p<0.001$). In female subjects there was a strong correlation between age and femoral or spinal FF ($\rho=0.73$, $p= 0.01$ and $\rho=0.90$ $p<0.001$ respectively), while in male subjects only spinal FF was correlated with age (spine: $r=0.45$, $p=0.02$, femur: $r=0.04$ $p=0.84$).

CONCLUSION

QGRE MRI is a fast, accurate and widely available, alternative for QCSI and allows quantification of MAT of the spine and femora with high spatial resolution. Gender and age specific differences in MAT should be taken in account when interpreting marrow FF.

CLINICAL RELEVANCE/APPLICATION

High vertebral MAT is associated with low bone mineral density and increased fracture risk. Accurate MAT quantification is necessary for the evaluation of MAT as a potential imaging biomarker.

SSA15-03 3T Chemical Shift Encoded MRI for Bone Marrow Adipose Tissue Composition Assessment

Sunday, Nov. 26 11:05AM - 11:15AM Room: S406B

Participants
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PURPOSE

Chemical Shift Encoded MRI (CSE-MRI) allows separation and quantification of water and fat in images. Recent improvements in such methods also allow assessment of fat composition, which may serve as a potential biomarker of osteoporosis. Our purpose is to apply such a method in the proximal femur bone marrow to assess subregional fat quantity and composition in a population of pre and post- menopausal women.

METHOD AND MATERIALS

This study had institutional review board approval and written informed consent was obtained. A multi gradient echo sequence at 3T (scan time = 3:32min) was used to acquire images of both hip of n=7 pre (25.75 +/- 3.58y) and n=6 post-menopausal women (59.83 +/- 3.58y). Using a dedicated reconstruction workflow we quantitatively assessed fat composition in bone marrow adipose tissue (bMAT) as depicted in figure 1. Using k-mean clustering, separation within bMAT of regulated (rMAT) and constitutive marrow adipose tissue (cMAT) was achieved. Regions of interest were draw in the: femoral head (FH), femoral neck (FN), Ward's triangle (WT), greater trochanter (GT), and proximal shaft (PS). The Mann-Whitney non-parametric test was used to compare results between groups.

RESULTS

Within bMAT of FN/WT, patients compared to controls demonstrated: higher SFA (+18.8%/32.1%) and lower PUFA (-30.6%/-

49.7%) and MUFA (-15.6%/-8.61%) (p<0.05 for all). Within rMAT of the FH, FN, WT, and GT patients compared to controsl demosntrated: higher SFA (+17.4%/+31.3%), lower PUFA (-38.3%/-59.5%), and lower MUFA (-8.3%/-25.1%) (p<0.05 for all). Within cMAT of FN and WT, patients compared to controls demontrated: higher SFA (+9.7%/+18.8%) and lower PUFA (-22.7%/-33.3%) and MUFA (-6.2%, FN only) (p<0.05 for all).

CONCLUSION

CSE-MRI can separate bMAT into rMAT/cMAT and detect sub-regional variation and differences in proximal femur fat composition and quantity in pre-post menopausal subjects in clinically feasible scan times.

CLINICAL RELEVANCE/APPLICATION

Chemical Shift Encoded MRI allows to assess bone marrow fat quantity and composition and allows discrimination between bone marrow adipose tissues in pre/post menopausal women.

SSA15-04 Quantification of Vertebral Bone Marrow Fat: Comparison of Six-Echo Modified Dixon with Single-Voxel MR Spectroscopy

Sunday, Nov. 26 11:15AM - 11:25AM Room: S406B

Participants
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Sun Jeong Moon, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To compare lumbar vertebral bone marrow fat-signal fractions obtained from six-echo modified Dixon sequence (6-E mDixon) with fractions from single-voxel MR spectroscopy (MRS) in patients with low back pain

METHOD AND MATERIALS

Vertebral bone marrow fat-signal fractions were quantified by modified Dixon with six-echoes and single-voxel MRS measurements in 23 patients. The point-resolved spectroscopy (PRESS) sequence was utilized for localized single voxel-MRS (TR = 3000 msec, TE = 35 msec, and total scan time = 1 minute 42 seconds). A 2×2×1.5 mm3 voxel was placed within the L3 vertebral body. The bone marrow fat spectrum was characterized based on the magnitude of measurable fat peaks and an a priori knowledge of the chemical structure of triglycerides. The imaging-based fat-signal fraction results were then compared to the MRS-based results.

RESULTS

There was a strong correlation between modified Dixon and MRS-based fat-signal fractions (slope = 0.842, r2 = 0.869, p < 0.001) (Figure 1). With Bland-Altman analysis, 91.3% (21/23) of data points were within the limits of agreement (Figure 2). Bland-Altman plots showed a slight but systematic error of modified Dixon based fat-signal fraction, which showed a prevailing underestimation of small fat-signal fractions and overestimation of high fat-signal fractions

CONCLUSION

Given its excellent agreement with single voxel-MRS, modified Dixon with six echoes can be used for visual and quantitative evaluation of vertebral bone marrow fat in daily practice.

CLINICAL RELEVANCE/APPLICATION

6-E mDixon allows equally accurate in quantifying vertebral bone marrow fat content as MRS and is potentially suitable for fat quantification in vertebral bone marrow

SSA15-05 Quantitative Standardization of Bone Marrow Imaging of Normal Vertebrae in Adults Using Dual-Source Dual-Energy CT Virtual Noncalcium Technique

Sunday, Nov. 26 11:25AM - 11:35AM Room: S406B

Participants
Hong Wang JR, Jinan, China (*Presenter*) Nothing to Disclose
Jiayang Fang, Jinan, China (*Abstract Co-Author*) Nothing to Disclose
Dexin Yu, Jinan, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the characteristics of bone marrow imaging and obtain the quantitative standard values of normal vertebrae in adults using dual-energy CT virtual noncalcium (VNCa).

METHOD AND MATERIALS

A total number of 200 cases who took physical examination were recruited to receive thoracolumbar spine imaging with dual-source dual-energy CT between August and November 2016. The CT values of bone marrow of T3-L5 vertebrae body were measured by using VNCa technique. Then on the basis of the measured CT values of vertebral body, four segments including T3-T5, T6-T9, T10-L1 and L2-L5 with approximative CT values were divided. The differences in such measurement parameters between different ages and genders were analyzed. Meanwhile, the average of the radiation dose of the scanning range was recorded.

RESULTS

The CT values of bone marrow in thoracic and lumbar vertebrae in young women were -27.76HU and -37.56HU, higher than those of older women with -37.80HU and -45.45HU (P<0.05). The CT values of the thoracic and lumbar vertebrae were -30.73HU and -33.74HU, which were significantly higher than those of the aged male with -46.07HU and -44.68HU (P<0.05). However, there were

no significant differences of the CT values of bone marrow in thoracic and lumbar vertebrae between the groups regarding gender (P>0.05). The measured CT values of bone marrow were negatively correlated with age (r=-0.4,P=0), while no significant correlation with sex (r=0.08,P=0.252). The average CT values of bone marrow of four segments were significant higher in younger cases between different age groups (P<0.05) and there were no significant differences of the average CT values of bone marrow between the groups regarding gender (P>0.05). In addition, the mean dose of the radiation was 8.33 mSv, which was 62.13% lower than that of the second generation dual source CT radiation.

CONCLUSION

VNCa bone marrow imaging with dual-source dual-energy CT of the quantitative CT value in normal thoracic and lumbar is more stable, and can provide an objective quantitative standard value for vertebral disease diagnosis.

CLINICAL RELEVANCE/APPLICATION

Dual-source dual-energy CT VNCa technique can provide quantitative standard of normal bone marrow which is helpful for the diagnosis of bone marrow lesions rather than using MRI as standard.

SSA15-06 Differential Diagnosis of Osteoblastic Metastases in Patients with Breast and Lung Cancer Using Dual-Energy Spectral CT Imaging

Sunday, Nov. 26 11:35AM - 11:45AM Room: S406B

Participants
Shaowei Zheng, Dalian, China (*Presenter*) Nothing to Disclose
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PURPOSE

To assess the diagnostic efficacy of dual-energy spectral CT in the evaluation of osteoblastic metastases (OBMs) in patients with breast cancer or lung cancer.

METHOD AND MATERIALS

17 patients with lung cancer and 21 patients with breast cancer underwent plain and contrast-enhanced CT scans of the thorax, abdomen or spine with dual-energy spectral imaging mode. The osseous metastases were at least 1cm in diameter with a relatively homogeneous density and the final diagnosis of was based on imaging and long-term clinical follow-up. The 140kVp polychromatic images and 11 sets of virtual monochromatic spectral images (40-140keV) for spectral CT in the plain (P), arterial phase (A) and venous phase (V) were evaluated. Regions of interest (ROI) were placed on the osteoblastic metastases covering 2/3 of the lesion and avoiding the bone cortex. The attenuation (CT value) of lesions was measured in all phases, and the increase in CT value (IV) was calculated as [IVAP=CTA-CTP; IVVP=CTV-CTP]. Independent sample t-test was used to compare the attenuation values of polychromatic and monochromatic spectral images. Receiver operator characteristic analysis was performed to compare the area under curve (AUC) for the differentiation of OBMs in patients with breast cancer and lung cancer.

RESULTS

65 OBMs (lung cancer: 38, breast cancer: 27) were confirmed. The CT value (CTP(140kVp), CTA(140kVp) and CTV(140kVp)) and enhancement (IVAP(140kVp) and IVVP(140kVp)) from the conventional 140kVp imaging did not show any significant difference between the two types of OBM, neither did the CT values from VMS images (p > 0.05). However, the enhancement value in venous phase (IVVP) from all monochromatic levels (40-140keV) showed significant difference between the two types of OBM (all p<0.05). Using 14.99HU as a threshold value for IVVP(110 keV), we obtained an AUC of 0.793 for differentiating OBMs from lung cancer(4.81± 17.40 HU) and breast cancer(35.32±46.10 HU), with a sensitivity of 0.778 and a specificity of 0.763.

CONCLUSION

Virtual monochromatic spectral imaging is superior to 140kVp images for the differentiation of OBMs from lung cancer and breast cancer.

CLINICAL RELEVANCE/APPLICATION

Dual-energy spectral CT can be used to help determine the primary source of bone metastasis.

SSA15-07 MRI and PET-CT Imaging Features of MPNST, Borderline and Benign Neurofibromas: Is it Possible to Anticipate Malignant Transformation?

Sunday, Nov. 26 11:45AM - 11:55AM Room: S406B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

-To describe which imaging features are characteristic of benign neurofibromas (BPNST) and which of Malignant Peripheral Nerve Sheath Tumors (MPNST) in patients with and without neurofibromatosis (NF) -To determine which MRI and PET-CT features are characteristic of borderline neurofibromas in NF -To determine if after the first malignant transformation, there is an increased frequency of malignant transformation in other neurofibromas. -To compare imaging features of BPNST and MPNST in patients with and without NF

METHOD AND MATERIALS

This is a retrospective study including patients with pathologically confirmed BPNST or MPNST between 2009 and 2016 who also had an MRI and/or PET-CT done before surgery. Patients characteristics: 60 tumors from 41 patients were included in our study, 19 males and 22 females. 26 patients had a genetically confirmed Neurofibromatosis and 15 patients did not have NF. Among these 60 tumors, 36 were considered BPNST and 24 MPNST. This data could be further divided into patients with and without NF. Imaging characteristics: An MRI previous to the diagnosis was available in all cases. More than one MRI was available in 23 tumors. PET-CT was performed in 20 tumors. MRI assessment: MRIs were reviewed retrospectively by 2 radiologists for the study of: Location, size, cystic/necrotic content, hemorrhage, margins, neighbouring structures, T1/T2 heterogenicity, T1/T2 signal, split-fat/target sign, DWI, ADC, enhancement pattern and edema. Pathology: All the tumors were included in Tissue arrays with a subgroup of 30 potential biomarkers selected.

RESULTS

-Significant differences between MPNST and neurofibromas were found in size, enhancement, perilesional edema, and necrotic areas. Borderline neurofibromas seem to share some of these imaging features, this could help radiologists to differentiate them from other BPNST. -PET-CT is a highly sensitive and specific for the diagnosis of MPNST (SUVmax range=3.77-6.35; mean SUVmax values=5.09). -The first malignant transformation increases the likelihood of degeneration within other neurofibromas.

CONCLUSION

MRI and PET-CT could help to differentiate neurofibromas,borderline neurofibromas and MPNST in NF patients.

CLINICAL RELEVANCE/APPLICATION

This scientific presentation could help radiologists to foresee which tumors will degenerate to MPNST as well as it could help NF patients to avoid multiple surgeries and aggressive treatments

SSA15-08 Retrospective Comparison of MRI Characteristics Distinguishing Lipomas and Well-differentiated Liposarcomas With and Without MDM2 or CDK4 Oncogene Amplification Testing

Sunday, Nov. 26 11:55AM - 12:05PM Room: S406B

Awards
Student Travel Stipend Award

Participants
Aaron D. Losey, MD,MS, San Francisco, CA (*Presenter*) Nothing to Disclose
Matthew D. Bucknor, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To analyze the MRI characteristics that distinguish lipomas from well-differentiated liposarcomas (WDL). Additionally, to compare the MRI characteristics between lipomas tested or not tested for MDM2 or CDK4 oncogene amplification and WDL tested or not tested for MDM2 or CDK4 oncogene amplification.

METHOD AND MATERIALS

A IRB-approved retrospective review of 115 patients with histologically proven lipomatous tumors was performed. Patients were grouped into lipomas and WDL based on histology, with or without oncogene testing. All patients underwent MRI imaging evaluating for size, location, percentage similar to host adipose tissue, thin or thick septations, nodularity, and enhancement. The associations between these features and tumor diagnoses were analyzed. Additionally, the associations between these features and oncogene testing between subgroups was explored. $P < .05$ was considered to indicate a statistically significant difference.

RESULTS

Of the 115 patients, 57 were classified as lipomas and 58 as WDL. Of the 57 lipomas, 24 had MDM2/CDK4 testing performed (negative). Of the 58 WDL, 28 had oncogene testing (positive). The mean age for the group with lipomas was 50 +/- 20 years and 60 +/- 14 years for the group with WDL (p=0.002). 46% of the group with lipomas was male and 52% for the group with WDL. The WDL group was more likely have a mass of larger size (p<0.001) and in a location other than the lower extremity (p=0.004) when compared to the lipoma group. There were no other statistically significant differences in the other imaging features. In the lipoma sub-group, lipomas tested for oncogene amplification were more likely to be larger (p<0.001) and demonstrate enhancement (p=0.03) when compared with lipomas not tested. The comparison between WDL tested for oncogene amplification and those not tested did not demonstrate statistically significant MRI characteristics.

CONCLUSION

While some of the imaging features of lipomas and WDL overlap, the WDL group was more likely to be of larger size and in a location other than the lower extremity. Additionally, negative oncogene testing has possibly increased the number of larger and/or enhancing lipomatous tumors that are characterized as lipomas.

CLINICAL RELEVANCE/APPLICATION

It is challenging to definitively characterize lipomatous tumors based on imaging. The use of oncogene testing for lipomatous tumors has altered imaging features associated with lipomas versus WDLs.

SSA15-09 CT Temporal Subtraction Method for Detection of Sclerotic Bone Metastasis in the Thoracolumbar Spine: JAFROC Observer Study

Sunday, Nov. 26 12:05PM - 12:15PM Room: S406B

Participants
Midori Ueno, MD, Kitakyushu, Japan (*Presenter*) Nothing to Disclose
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Hyoungseop Kim, PhD, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Although CT is a routine imaging modality to survey many types of cancer, bone metastases are often missed at CT because of their subtle findings. We have developed a new temporal subtraction (TS) method in order to significantly reduce misregistration artifacts on the subtraction images in successive thoracic CTs, and have shown that TS can improve the diagnostic accuracy of lung nodules. However, the performance of TS for the detection of the bone metastasis has not been clarified. The purpose of this study is to assess the effectiveness of a CT-TS methods for radiologist's performance in sclerotic metastasis detection in the thoracolumbar spine.

METHOD AND MATERIALS

Twenty pairs of standard-dose 1mm-thick CT and their TS images in patients with sclerotic bone metastasis and 20 pairs of those in patients without bone metastasis were used for an observer performance study. A total of 137 lesions were identified as the reference standard of actionable lesions (sclerotic metastasis newly appeared or increased in size) by two musculoskeletal radiologists. Eight radiologists (four attending radiologists and four radiology residents) participated in this observer study. Ratings and locations of "lesions" determined by the observers were utilized for assessing the statistical significance of differences between radiologists' performances without and with the CT-TS images in JAFROC analysis. The statistical significance of differences in the reviewing time was determined by use of a two-tailed paired Student's t test.

RESULTS

The average figure-of-merit (FOM) values for all radiologists increased to a statistically significant degree, from 0.856 without the CT-TS images to 0.884 with the images (P=.037). The average sensitivity for detecting the actionable lesions was improved from 60.7 % to 72.5 % at a false-positive rate of 0.15 per case by use of the CT-TS images. The average reading time with CT-TS images was significantly shorter than that without (150.6 seconds vs. 166.5 seconds, P=.004).

CONCLUSION

The use of CT-TS would improve the observer performance for the detection of the sclerotic bone metastasis in the thoracolumbar spine.

CLINICAL RELEVANCE/APPLICATION

A CT temporal subtraction method can sufficiently assist not only the radiologists' diagnostic accuracy but also their interpretation time for the detection of sclerotic bone metastasis in the thoracolumbar spine.

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SSA16

Science Session with Keynote: Nuclear Medicine (Prostate Cancer Imaging)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S505AB

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AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

Ukihide Tateishi, MD, PhD, Tokyo, Japan (*Moderator*) Nothing to Disclose
Peter L. Choyke, MD, Rockville, MD (*Moderator*) Researcher, Koninklijke Philips NV; Researcher, General Electric Company; Researcher, Siemens AG; Researcher, iCAD, Inc; Researcher, Aspyrian Therapeutics, Inc; Researcher, ImaginAb, Inc; Researcher, Aura Biosciences, Inc

Sub-Events

SSA16-01 Nucler Medicine Keynote Speaker: Introduction to Prostate Cancer PET Imaging and Theranostics

Sunday, Nov. 26 10:45AM - 10:55AM Room: S505AB

Participants
Steven P. Rowe, MD, PhD , Parkville, MD (*Presenter*) Nothing to Disclose

SSA16-02 Initial Experience with Commercial 18F-Fluciclovin

Sunday, Nov. 26 10:55AM - 11:05AM Room: S505AB

Participants
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PURPOSE

The non-natural amino acid anti-1-amino-3-18F-fluorocyclobutane-1-carboxylic acid (FACBC, Fluciclovine, Axumin) is a PET tracer approved by the U.S. Food and Drug Administration (FDA) for the detection and localization of biochemically recurrent prostate cancer. While the performance of Axumin PET/CT imaging in clinical trials is well documented, its performance in clinical practice is unknown. We aim to evaluate the positivity rate for the patients scanned with Axumin PET/CT as part of their clinical workup.

METHOD AND MATERIALS

A retrospective review of patients who underwent 18F-Fluciclovine PET/CT (Axumin) imaging at our institution secondary to suspect prostate cancer recurrence based on rising prostate specific antigen (PSA) levels, was conducted between December 2016 through March 2017. Images were interpreted by nuclear medicine board certified and Axumin expert reader physicians. Patient demographics and positivity rate were evaluated.

RESULTS

37 patients (Pts) with a median age of 68 years (range 52-83 years) and most recent mean PSA level of 2.9 ng/ml underwent Axumin imagng. For their initial treatment, 10 pts underwent radical prostatectomy (RP), 7 pts had radiation (RT), 1 pt had hormonal therapy (HT), and 19 pts had combination (12 RP+RT, 4 RP+HT, 2 T+HT, 1 RP+RT+HT). 32/37 pts (86%) had positive Axumin PET/CT scan whereas 5/37 pts (14%) were described as negative. The scan was positive within the prostate bed in 12 pts (37.5%) and extraprostatic lesions were detected in 20 pts (62.5%). In 16 pts with PSA level < 1.0 ng/ml, positivity rate was 75 % (12/16). Indolent suspicious bone lesions noted in 4/37 (11%) pts. Only 2 pts had available biopsy conformation; 1 true positive in the prostate bed and 1 was metastasis to deep pelvic lymph node. 2 pts with positive bone lesions were evaluated with MRI; 1 lesion was defined as false positive with a negative MRI and one defined as true positive with positive MRI. One patient had biopsy that was true positive for a second primary cancer.

CONCLUSION

Initial experience with commercial Axumin PET/CT scan was found to demonstrate high positivity rates in patients with suspected prostate cancer recurrence.

CLINICAL RELEVANCE/APPLICATION

Positivity rate has been described in a selected population under strict clinical trials. Evaluation of the commercially scanned patients will help understand the impact of the scan in clinical practice.

SSA16-03 Correlation of Intraprostatic 68Ga-PSMA11-PET/CT Tracer Uptake with PSA, Gleason Score and d'Amico Risk Classification in Treatment-Naive Men with Newly Diagnosed Prostate Cancer

Sunday, Nov. 26 11:05AM - 11:15AM Room: S505AB

Participants
Stefan A. Koerber, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
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Clemens Kratochwil, MD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
Claudia Kesch, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
Andrei Iagaru, MD, Stanford, CA (*Abstract Co-Author*) Research Grant, General Electric Company
Frederik L. Giesel, MD, MBA, Heidelberg, Germany (*Presenter*) Patent application for F18-PSMA-1007
Matthias F. Haefner, MD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
Walter Mier, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
Juergen Debus, MD, PhD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
Uwe Haberkorn, MD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

68Ga-PSMA11-PET/CT is an uprising and promising diagnostic tool for patients in recurrent prostate cancer (PCa). However, only limited in vivo data is available evaluating PSMA uptake as a primary diagnostic tool and its correlation with several clinical parameters. Our study evaluates maximal standardized uptake values (SUVmax) in benign prostate tissue and malignant, intraprostatic tumor lesions and its correlation with several clinical parameters (PSA, Gleason Score, d'Amico risk).

METHOD AND MATERIALS

104 treatment-naïve men with biopsy proven prostate carcinoma were included in this study. SUVmax of intraprostatic lesions was measured as indicated by biopsy and MRI-results. Data was compared with current prostate specific antigen (PSA) values, Gleason Score (GS), ISUP-grade and d'Amico risk classification. Furthermore, we evaluated SUVmax-values in patients with clearly delineated benign intraprostatic tissue to determine a cut-off-value for tumor lesion (n = 42).

RESULTS

We measured a mean SUVmax of 1.88 ± 0.44 in benign intraprostatic tissue compared to 10.77 ± 8.45 in malignant, intraprostatic lesions ($p < 0.001$). A significantly higher PSMA-uptake in PSMA-PET/CT for patients with higher PSA, higher GS and higher risk according to d'Amico was observed ($p< 0.001$, respectively).

CONCLUSION

68Ga-PSMA11-PET/CT is well suited for the detection of dominant intraprostatic tumor lesion of patients with primary staging. Our findings from a large cohort suggest a significant relation of intraprostatic PMSA-uptake with PSA, GS and d'Amico risk classification. These findings indicate that PSMA-PET/CT could be helpful in various clinical settings, such as biopsy guidance, radiooncological management and further treatment stratification.

CLINICAL RELEVANCE/APPLICATION

68Ga-PSMA-PET/CT offers an excellent diagnostic tool for prostate cancer patients. To our knowledge, there is still limited data regarding intraprostatic tracer uptake and clinical parameters, which might be very useful for treatment planning in radiation oncology or biopsy-guidance. Therefore, we evaluated differences of SUV measurements in malignant and healthy prostate tissue and correlated SUV with Gleason Score, PSA and d'Amico risk classifikation in a large cohort of treatment-naive men with prostate cancer.

SSA16-04 68Ga-PSMA-11 PET/MRI in Primary Intermediate/High-Risk Prostate Cancer

Sunday, Nov. 26 11:15AM - 11:25AM Room: S505AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Extensive investigation of 68Ga-PSMA-11 PET has shown high detection rates in men with recurrent prostate cancer after treatment. However, data is limited for evaluation (alone or as a hybrid system) at initial diagnosis. We report the diagnostic performance of 68Ga-PSMA-11 PET/MRI prior to prostatectomy in patients with intermediate or high-risk cancer.

METHOD AND MATERIALS

We recruited twenty men without metastatic disease on conventional imaging (CT or MRI and bone scintigraphy) who were scheduled for radical prostatectomy with pelvic lymph node dissection. A mean dose of 4.2 ± 0.6 mCi (155.4 ± 22.2 MBq) of 68Ga-PSMA-11 was administered. Whole-body images were acquired starting 43-61 minutes post-injection using a GE SIGNA PET/MR, followed by an additional pelvic PET/MRI acquisition (including conventional multiparametric MRI sequences) 42-67 minutes later. PET/MRI findings were compared to preoperative diagnostic MRI and correlated with final pathology.

RESULTS

Preoperative 68Ga-PSMA 11 PET identified intraprostatic cancer foci in all 20 patients, whereas mpMRI alone identified PIRADS 4 or 5 lesions in 16 patients and PIRADS 3 in two patients. PET/MRI demonstrated focal uptake in pelvic lymph nodes in three patients. Final pathology confirmed cancer in the prostate of all patients, as well as nodal metastasis in two. No patient with normal pelvic nodes on PET/MRI had cancer in the nodes on final pathology. Tracer accumulation increased overall at later acquisition times, with higher SUVs (mean: 16.6 vs 13.4, P=0.006). However, no additional lesions were identified on delayed imaging.

CONCLUSION

68Ga-PSMA-11 PET/MRI correctly identifies foci of cancer within the prostate while MRI provides detailed anatomical guidance for the location of abnormal uptake. 68Ga-PSMA-11 PET/MRI provides valuable information even in the setting of negative conventional imaging, and may inform the need for and extent of pelvic node dissection.

CLINICAL RELEVANCE/APPLICATION

68Ga-PSMA-11 PET/MRI offers incremental value over a dedicated prostate MRI and bone scan, and is recommended in the pre-operative evaluation of prostate cancer patients.

SSA16-05 Incremental Diagnostic Value of 68Ga-PSMA-HBED-CC PET Imaging over Transrectal Ultrasound-Guided Prostate Biopsy for Prostate Carcinoma

Sunday, Nov. 26 11:25AM - 11:35AM Room: S505AB

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PURPOSE

Transrectal ultrasound-guided biopsy (TRUSGB) for evaluation of prostate carcinoma (PCa) is known to be operator-dependent and subject to sampling errors, sometimes leading to delayed diagnosis and misclassification. In this study, we aim to explore whether 68Ga-PSMA PET has an incremental value over TRUSGB for evaluation of PCa.

METHOD AND MATERIALS

Our study consecutively recruited 38 patients (mean age: 66+/-6 y, range: 55-80 y) to compare their 68Ga-PSMA PET/CT findings with TRUSGB results before radical prostatectomy. SUVmax ratio of lesion to background prostatic tissue (LB ratio) were measured and assessed by receiver-operating characteristic (ROC) curve analysis to determine the cut-off LB ratio for diagnosis of prostate cancer involvement on a lobar basis. The difference in diagnostic accuracy was based on the ability of TRUSGB or PET in diagnosing presence or absence of tumor, and in correct lobar lateralization of tumor when compared with the final gold standard of prostatectomy histopathology.

RESULTS

Prostatectomy histopathology confirmed PCa in 66/76 lobes. TRUSGB detected 49/66 (74.2%). 68Ga-PSMA PET, at a cut-off LB ratio of 1.4, identified 56/66 (84.8%) PCa lobes with specificity 90% (9/10), accuracy 85.5% (65/76) and AUC 0.88. 68Ga-PSMA PET identified 5 PCa lobes in 3 patients having negative TRUSGB results, which prompted for a 2nd biopsy guided by spatial localization with 68Ga-PSMA PET and confirmed the diagnosis of PCa. In addition, 68Ga-PSMA PET/CT identified 8 patients with bilateral PCa involvement who were initially diagnosed as unilateral PCa by TRUSGB. On a lobar bases, the incremental value of 68Ga-PSMA PET over TRUSGB was significant (93.9%, 62/66 vs 74.2%, 49/66, P<0.05). On a patient basis, combined use of two techniques could detect PCa in all patients.

CONCLUSION

Combined use of 68Ga-PSMA PET/CT has an incremental value over TRUSGB alone for diagnosis of PCa. It may also provide valuable localization information for targeted biopsy sampling, especially for the patients with negative initial biopsy or those who are reluctant for biopsy.

CLINICAL RELEVANCE/APPLICATION

68Ga-PSMA PET/CT might increase the accuracy of TRUSGB by providing more accurate PCa location, thus changing the management from passive surveillance to prostatectomy.

SSA16-06 Whole-Body 18F-PSMA-1007-PET/MRI with Integrated Multiparametric Prostate Imaging Protocol for Comprehensive Staging of Patients with Prostate Cancer

Sunday, Nov. 26 11:35AM - 11:45AM Room: S505AB

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PURPOSE

To explore the feasibility, reproducibility and PET-artifact presence of a 18F-PSMA-1007-PET/MRI protocol for imaging high-risk prostate cancer (PC) patients.

METHOD AND MATERIALS

After 18F-PSMA-1007-PET/CT was performed (1h p.i.) as reference, eight patients with proven high-risk PC underwent a whole-body PET/MRI (3h p.i.) including a multi-parametric PI-RADS 2.0 compliant prostate protocol using a prototype CAIPIRINHA-accelerated attenuation correction. SUVmean-quantification for reproducibility was performed using a 3D-isocontour volume-of-interest. PET-artifacts (Cohen's kappa), co-registration of prostate PET/MRI (>3mm shift between bladder outline in PET and MRI) and prostate MRI (PI-RADS 2.0) were assessed.

RESULTS

The examinations were well accepted by patients and comprised 1 hour. SUVmean-VOIs between PET/CT (1h p.i.) and PET/MRI (3h p.i.) were linear (PET/CT 9.0±5.0, PET/MRI 11.4±6.1, p<0.0001 pathological VOIs and PET/CT 19.6±7.5, PET/MRI 21.8±10.4, p<0.0001 physiological VOIs) demonstrating reproducibility. Mostly slight to moderate photopenic artifacts were noticed in PET/MRI in the abdomen, surrounding liver and kidneys (kappa 0.82 (CI 0.62-1.00)) with a mean of 1.13±0.99 (reader 1) and 1.38±0.74 (reader 2). Both readers agreed to 100% that the PET-component of the PET/MRI did not reveal any artifacts in head/neck and thorax. Both readers agreed to 100% that the PET-component of the PET/CT did not reveal any artifact in the four compartments defined. All acquisitions of PET and MRI of the prostatic fossa obtained simultaneously could be co-registered with optimal match of bladder volume between both modalities. All patients featured PI-RADS 5 findings.

CONCLUSION

The presented 18F-PSMA-1007-PET/MRI protocol combines efficient whole-body assessment with high-resolution co-registered PET/MRI of the prostatic fossa, cinically feasible in 1 hour. Moderate photopenic artifacts were noticed surrounding high-contrast areas liver and kidneys. This promising protocol is proposed as a comprehensive staging for patients with prostate cancer exploiting the optimal tracer biodistribution of 18F-PSMA-1007 (low bladder clearance) and the combination of T-(MRI) and N-/M-staging (PET and MRI).

CLINICAL RELEVANCE/APPLICATION

We propose an innovative 18F-PSMA-1007-PET/MRI protocol that combines molecular and functional information for comprehensive staging of prostate cancer patients

SSA16-07 Biochemical Recurrence of Prostate Cancer: Initial Results of 18F-PSMA-1007

Sunday, Nov. 26 11:45AM - 11:55AM Room: S505AB

Participants
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PURPOSE

The clinical introdcution of 68Ga-PSMA-11 relevantly improved prostate cancer imaging. However, 68Ga-labelled tracers are limited by production capacity and short half-life. 18F-labelled ligands such as DCFPyL and PSMA-1007 have benn developed to solve this limitation. Additionally, in the pelvis PSMA-1007 benefits from low kidney clearance resulting in almost no urinary bladder uptake of tracer-associated activity. In this study, we analyzed the diagnostic potential of PSMA-1007 in PCa patients with biochemical recurrence (BCR).

METHOD AND MATERIALS

Seven patients (median age 72) with BCR (PSA mean = 1.78 ng/mL) underwent PET/CT-scans 1h and 3h after injection of 18F-PSMA-1007 (mean injection activity: 247 MBq). Biodistribution in normal organs as well as tumor uptake and lesion morphology (size) were examined.

RESULTS

PSMA-1007 was tolerated well in all 7 patients without any adverse events. PSMA PET/CT detected local recurrence (n=2; PSA 1.9 and 3.6 ng/ml), lymph node metastases (n=2; PSA 0.16 and 2.0 ng/ml), and bone metastases (n=1; PSA 3.8 ng/ml). In two patients suspective PET-positive findings were not observed (n=2; PSA 0.4 and 0.5 ng/ml). In all tumor lesions tracer uptake increased from 1h p.i. (mean SUVmax 8.4) to 3h p.i. (mean SUVmax 14.1). Histological validation of one patient with LN-metastases and response to succeeding radiotherapy confirmed true-positive findings clinically; distant metastases were not confirmed and treated with androgen-deprivation therapy. The diagnosed LN-metastases were below radiological criteria (SAD median = 5.2 mm, minimum = 3.5 mm) and focal therapy would not have been an option with conventional staging alone.

CONCLUSION

In this pilot study 18F- PSMA-1007 PET/CT presented high potential for non-invasive localization diagnostics in prostate cancer patients with BCR. Local recurrence was well delineable due to the low urine activity background in bladder and urethra and might present advantageously in comparison to other PSMA radiotracers in this setting.

CLINICAL RELEVANCE/APPLICATION

18F-PSMA-1007 performs at least comparably to 68Ga-PSMA-11, but its longer half-life, superior engery characteristics and non-urinary excretion might overcomes some practical limitations of 68Ga-labelled PSMA-targeted tracers.

SSA16-08 Quantitative Multiparametric MRI and DCFBC PET/CT in Primary Prostate Cancer: Combined Association for Identification of Aggressive Disease

Sunday, Nov. 26 11:55AM - 12:05PM Room: S505AB

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PURPOSE

Multiparametric MRI (mpMRI) is often used in diagnosing prostate due to its high sensitivity, but suffers from low specificity regarding assessment of disease aggressiveness. Molecular imaging agents such as Prostate Specific Membrane Antigen (PSMA) targeting by 18F-DCFBC PET/CT have shown progress in defining aggressive cancer phenotypes. The purpose of this study is to correlate quantitative information from MRI and PET data to determine if the combination can provide better characterization of the cancer phenotype.

METHOD AND MATERIALS

Thirteen patients with localized prostate cancer underwent both mpMRI and 18F-DCFBC PET/CT scans followed by targeted TRUS/MRI guided biopsy or radical prostatectomy. Registered PET/mpMRI images were correlated with pathology. For each lesion, mean and 10th percentile ADC from mpMRI, maximum and mean Standardized Uptake Value (SUV) from 18F-DCFBC PET/CT were calculated. ADC and SUV values were correlated on voxel-level and ROI-level using spearman's rank and each with Gleason score using kendall's tau. Ability of mpMRI and 18F-DCFBC PET metrics to predict Gleason scores >=4+3 was assessed by logistic regression, using generalized estimating equation to account for intra-patient correlation.

RESULTS

Twenty-five lesions were identified by two blinded reviewers across both modalities with sensitivity in lesion detection on mpMRI superior to 18F-DCFBC PET/CT (96% vs. 36%). Quantitative analysis was feasible in 22 lesions. SUVmax and ADC10 showed moderate correlations with Gleason scores (τ=-0.36-0.4), additionally showing a weak correlation to one another (ρ=0.26). These metrics significantly distinguished between Gleason <=3+4 (N=10) or >=4+3 (N=12) in univariate logistic regression model. In a bivariate model, higher SUVmax remained significantly associated with Gleason >=4+3 (SUVmax log-odds ratio 1.84, p=0.02; ADC10 log-odds ratio -0.512, p=0.09).

CONCLUSION

18F-DCFBC PET/CT showed poor sensitivity in detecting all malignant lesions; however, when combined with mpMRI, SUV was significantly associated with aggressive prostate cancer (Gleason >=4+3). The results of this preliminary analysis form the basis for an expanded study with immunohistochemical staining for key driver proteins.

CLINICAL RELEVANCE/APPLICATION

Identification of aggressive phenotypes is critical for understanding prostate cancer progression, correlation of multiple staging scans can provide enhanced characterization beyond either alone.

SSA16-09 177Lutetium PSMA Radioligand Therapy in Patients with Metastatic Castration Resistant Prostatic Cancers: Assessment of Response, Clinical Evaluation, Toxicity - First Study in India

Sunday, Nov. 26 12:05PM - 12:15PM Room: S505AB

Awards
Trainee Research Prize - Resident

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PURPOSE

RLT with 177-Lu-DKFZ-617-PSMA is a novel targeted therapy for mCRPC. To assess the efficacy of single infusion of 177-Lutetium-DKFZ-617-PSMA Radioligand Therapy by prostate specific antigen (PSA), biochemical, clinical and radiological responses, and early side effects.

METHOD AND MATERIALS

RLT with 177-Lu-DKFZ-617-PSMA was performed in 11 mCRPC patients. 68GaHBED-CC PET-CT was performed in all patients prior to one cycle RLT (Mean administered activity 7.03 GBq and range 6.67 - 7.4 GBq). In addition, early response was evaluated by serum PSA levels, CBC, LFT, RFT, serum electrolytes, LDH, ionsed calcium prior to and followed by 2, 4, 6 and 10 weeks post therapy.

RESULTS

All lesions detected by 68Ga-HBED-CC PSMA PET-CT exhibited high 177-Lu-DKFZ-617-PSMA uptake on post therapy planar and SPECT images. 10 weeks after therapy 7 patients (63.63%) experienced PSA decline of whom 2 patients (18.18%) experienced more than 50% PSA decline and 4 patients (36.36%) experienced rise in PSA out of which 3 patient (27.27%) experienced more than 30 % raise in PSA. Relevant hematotoxicity (ECOG CTC and CTCAE) i.e. grade 3 / 4 anemia in 18.18% and grade 1 / 2 in 27.27%, and grade 3 / 4 thrombocytopenia in 18.18 %, and grade 1 / 2 leucopenia in 27.27% has experienced. 3 patient (27.27%) experienced deranged LFT by grade 1 / 2. One patient (9.09%) has experienced grade 1 changes in RFT . Hyponatremia grade 3 / 4 experienced in 18.18%. and grade 2 in 9.09%, hypocalcaemia grade 2 in 9.09%, and hypophosphatemia grade 1 in 9.09% of patients. There is grade 4 raise in LDL seen in 9.09% patients, grade 3 raise in ALP in 18.18% and grade 1 in 27.27% patients are seen, whereas low ionized calcium with grade 1 changes are seen in 27.27% patients. Xerostomia was experienced by 4 patients (36.36%).

CONCLUSION

177-Lu-DKFZ-617-PSMA RLT is a novel and promising treatment for mCRPC. Our initial results indicate that 177-Lu-DKFZ-617-PSMA RLT is safe, effective and have low early side effect profile. A relevant PSA decline was detected in 63.63 % of patients with six month progression free survival.

CLINICAL RELEVANCE/APPLICATION

(dealing with prostate cancer) '68Ga-HBED-CC PSMA PET-CT study demonstrate upstaging as compared to conventional FDG PET CT. All lesions detected by 68Ga-HBED-CC PSMA PET-CT exhibited high 177-Lu-DKFZ-617-PSMA uptake on post therapy planar and SPECT images. This scan and therapy is highly recommended in the management of prostate cancer.

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SSA17

Neuroradiology (Brain Tumors: Beyond the Frontier)

Sunday, Nov. 26 10:45AM - 12:15PM Room: N228

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSA17-01 Non-invasive Prediction of Isocitrate Dehydrogenase (IDH) Genotype in Grade-II Gliomas with Amide Proton Transfer-Weighted (APTw) MR Imaging

Sunday, Nov. 26 10:45AM - 10:55AM Room: N228

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PURPOSE

Mutations in isocitrate dehydrogenase (IDH) genes are associated with favorable prognosis in patients with gliomas. Compared to oncogenic HRAS IDH1-wild type glioma cells, global downregulation of protein expression in mutant IDH1-driven glioma cells was found. Amide proton transfer-weighted (APTw) imaging is a molecular technique that gives contrast based in large part on endogenous cytosolic proteins and peptides. This study is to test the hypothesis that APTw signal is a surrogate imaging maker for identifying IDH mutation status preoperatively.

METHOD AND MATERIALS

Patients with suspected low-grade glioma were scanned at 3T clinical MRI scanner. APTW images were calculated using MTRasym(3.5ppm). Operative tissue samples were processed IDH1-R132H evaluation, which was performed by IHC and DNA sequencing, as described previously. Quantitative APTw parameters obtained from multi-ROI-based (maximum and minimum) and whole-tumor histogram-based (mean, variance, skewness, kurtosis, slop, 10th percentile, 50th percentile, 90th percentile, and peak) APTw metrics were compared between IDH-mutant and IDH-wildtype groups. Mann-Whitney test was used to evaluate the difference of APTw parameters between two glioma groups, and the receiver-operator-characteristic (ROC) analysis was used to assess the APTw diagnostic performance.

RESULTS

27 patients fulfilled eligibility criteria were recruited. Seven cases were diagnosed as IDH-wildtype grade-II gliomas, and 20 cases as IDH-mutant grade-II gliomas. The maximum and minimum APTw values based on multiple regions of interest, as well as the whole-tumor histogram-based mean and 50th percentile APTw values were significantly higher in the IDH-wildtype gliomas than in the IDH-mutant groups, corresponding to the areas under the ROC curves of 0.80, 0.91, 0.75, and 0.75 respectively, in predicting the IDH mutation status.

CONCLUSION

IDH-wildtype lesions were associated with relatively high APTw signal intensities, compared with IDH-mutant lesions. APTw imaging has the potential for discriminating IDH genotypes in grade-II gliomas non-invasively.

CLINICAL RELEVANCE/APPLICATION

The APTw signal could be a valuable imaging biomarker by which to identify IDH1 mutation status in grade-II gliomas without surgery, which could provide supplementary information about the diagnosis.

SSA17-02 MGMT Promoter Methylation Assessment of Glioblastoma Using Three-Dimensional Texture Features

of Multimodal MRI

Sunday, Nov. 26 10:55AM - 11:05AM Room: N228

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PURPOSE

O6-methylguanine methyl transferase (MGMT) gene promoter status are significant for treatment strategy and prognosis prediction of patients with glioblastoma(GBM). We aimed to verify that texture features derived from multimodal magnetic resonance images (MRI) may be potential for noninvasive and well-repeatable detection of MGMT promoter methylation status.

METHOD AND MATERIALS

Total 73 patients with GBM were enrolled (35 and 38 with and without MGMT promoter methylation, respectively). For each patient, volumes of interest (VOIs) were delineated on ten MRI modalities or parametric maps. Three-dimensional (3D) grey-level co-occurrence and curvature co-occurrence matrix (GLCM and GLGCM) textural features were extracted from each VOIs. Then the support vector machine (SVM) based feature selection and classification strategies were proposed to firstly obtain an optimal feature subset and then verify and improve its capacity to identify whether the patient was with MGMT promoter methylation or not, corresponding receiver operating characteristic (ROC) curve were depicted.

RESULTS

Total 420 3D GLCM and GLGCM features were extracted from ten MRI modalities/parametric maps for each of the 73 patients. After feature selection, 23 features were determined as the optimal feature subset, and the accuracy, sensitivity, specificity and area under ROC curve for identifying MGMT promoter methylation reached to 82.19%, 83.78%, 80.56% and 0.9204, respectively. In optimal subset, features derived from structure and perfusion modalities contributed more in detecting MGMT promoter methylation of GBM, comparing with those derived from diffusion modalities.

CONCLUSION

In this study, an optimal subset of 23 features was selected and its classification performance indicated that they may be a potential imaging biomarkers for predicting MGMT promoter methylation status.

CLINICAL RELEVANCE/APPLICATION

1. For patients with glioblastoma, MGMT promoter status assessment is crucial because MGMT methylation is associated with better prognosis and chemotherapy response. 2. The proposed radiomics approach based on multimodal MRI has the potential to accurately assess the MGMT promoter status before clinical intervention. 3. Texture features derived from structure and perfusion modalities contributed more to MGMT promoter methylation detection of patients with glioblastoma, comparing with those derived from diffusion modalities

SSA17-03 Texture Analysis of Quantitative Apparent Diffusion Coefficient Maps to Differentiate Between High-Grade Gliomas and Metastatic Brain Tumor

Sunday, Nov. 26 11:05AM - 11:15AM Room: N228

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the diagnostic value of texture parameters of Apparent Diffusion Coefficient(ADC) maps to differentiate between High-grade gliomas(HGG) and brain metastasis(METS)

METHOD AND MATERIALS

The ADC maps of the Diffusion Weighted Images of 82 patients of which 50 were pathologically confirmed with HGG and 32 with METS were recorded using ADW 4.6 workstation Functool2 software. Using Omnikinetics Software,3D merged Region Of Interests images of intratumoral and peritumoral regions were delineated. The texture parameters namely First order parameters including MIN, MAX, MI , skewness, kurtosis, MD, RD, VVS, RMS, uniformity, VC; Grey-level co-occurence matrix parameters inlcuding energy, entropy, correlation, IDM, CP and Grey-level run length maxia parameters including GLN, RLN , LGLRE, HGLRE, SRLGLE, SRHGLE, LRLGLE and LRHGLE were reported. Shapiro-Wilk test for normality and independent sample t-test (parametric) and Mann-Whitney u test(non-parametric) were carried out for statistical analysis(spss 20.0). Logistic regression tests were used to evaluate

independent risk factors. ROC curve tests were performed to calculate AUC, cut-off values, sensitivity and specificity.

RESULTS

1) VC (p=0.009), VVS (p=0.013), RMS(p=0.000), RD (p=0.042), correlation(p=0.016), energy(p=0.000), Entropy(p=0.000), GLN (p=0.009), RLN (p=0.005), LGLRE (p=0.023), SRLGLE (p=0.030), LRLGLE (p=0.000) and LRHGLE (p=0.000) between HGG and METS are statistically significant. 2) Mean±S.D. values of MIN, MAX, MI, MD, skewness, Kurtosis, VC, RMS, uniformity, RD, entropy, correlation, IDM, CP, GLN, RLN, HGLE, SRHGLE and LRHGLE of HGG are higher than METS. 3) Logistic regression tests suggest VC(p=0.009), VVS(p=0.010), RMS(p=0.000), GLN(p=0.010)and RLN(p=0.005) to contribute significantly to accurate prediction as independent risk factors with a joint model prediction accuracy of 93.9%. 4) ROC curve analysis shows AUC=0.955, 0.684, 0.672, 0.671, 0.663, 0.659 & 0.634 and sensitivity = 91.8%, 81.6%, 77.6%, 67.3%, 75.5%, 79.6%& 67.3% for entropy, RLN, VC, GLN, VVS, correlation & RD respectively.

CONCLUSION

Texture analysis parameters of quantitative ADC maps based on entire tumor serves as good differentiating diagnostic indices of HGG and METS.

CLINICAL RELEVANCE/APPLICATION

Whole Tumor ADC map differentiation of HGG and METS (appear similar on CT/MR imaging but follow different treatment protocols) using texture analysis can improve treatment and therapeutic response.

SSA17-04 Detection of 2-Hydroxyglutarate Using Spectral Editing MRS in Patients with IDH Mutant Gliomas

Sunday, Nov. 26 11:15AM - 11:25AM Room: N228

Participants
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PURPOSE

To assess the diagnostic accuracy of in vivo MRS for the detection of the tumor specific imaging marker D-2-hydroxyglutarate (2-HG) produced by IDH mutant gliomas.

METHOD AND MATERIALS

We prospectively enrolled 14 preoperative patients with grade II or III diffuse gliomas. Each patient underwent an MR examination which included a spectral editing MRS (MEGA-PRESS) to edit the 2-HG Ha resonance at 4.02 ppm, dynamic contrast-enhanced (DCE) imaging and multi-b value diffusion-weighted imaging on a 3T MR scanner. Automatic shimming was performed using the vendor's pre-scan shimming routines. Parameters for the MEGA-PRESS sequence were: TR=2000ms, TE=60ms, 64 acquisitions, voxel size=8 cm3, duration=4.5min. The 2HG Ha resonance of the substracted MEGA-PRESS spectra was analyzed using jMRUI v5.2. Plasma volume (Vp) and volume transfer constant (Ktrans) were calculated from DCE-imaging. Apparent diffusion coefficient (ADC) values were obtained from diffusion-weighted imaging. A radiologist blinded to the IDH status placed multiple small region-of-interests on the Vp, Ktrans and ADC maps. The maximum Vp/Ktrans and the minimum ADC values were kept for each patient ("hot spot analysis"). Following the biospy or surgical resection, a neuropathologist determined the grade and type of glioma using the 2016 WHO classification. IDH mutation status was identified via immunohistochemical detection of IDH1 R132H.

RESULTS

Of the 14 patients, there were 7 with grade III anaplastic astrocytomas, 4 with grade III anaplastic oliodendrogliomas, 2 with grade II astrocytomas and 1 patient with grade II oligodendroglioma. Ten patients harbored the IDH mutations and 4 patients were IDH wild-type. For the detection of 2-HG, MRS had a 40% sensitivity, 100% specificity, 100% postitive predictive value and 40% negative predicitve value. From the hot-spot analysis, there was no significant difference between Vp, Ktrans and ADC values between IDH mutant and wild-type gliomas (P=0.88, P=0.06 and P=0.78 respectively).

CONCLUSION

Spectral eding MRS can detect 2-HG in patients with IDH mutant gliomas with high specificity. In the future, the sensitivity of this technique may be improved by using a larger voxel size, increasing the number of acquisitions or performing manual shimming.

CLINICAL RELEVANCE/APPLICATION

Spectral editing MRS can be used to preoperatively detect IDH mutant positive status in patients presenting with a newly suspected glioma.

SSA17-05 Non-Invasively Detecting Isocitrate Dehydrogenase 1(IDH1) Mutation Using Non-Gaussian Diffusion MR Imaging in Lower-Grade Gliomas: Primary Results

Sunday, Nov. 26 11:25AM - 11:35AM Room: N228

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PURPOSE

To explore the feasibility of non-invasively detecting the status of isocitrate dehydrogenase 1 (IDH1) mutation using non-Gaussian diffusion MR imaging in lower-grade gliomas (LGG) including grade2and grade 3.

METHOD AND MATERIALS

Ninety cases with pathologically confirmed lower-grade glioma (WHO grade2:n=64;WHO grade 3:n=26) were enrolled in this prospective study, who performed the uniformed imaging protocol of T1WI, T2WI, T2-Flair , DWI with 2 b values (0, 1000 s/mm2) and 22 b values (<=5000 s/mm2), and contrast-enhanced T1WI (CE-T1WI),respectively. Based on the results of the immunohistologic chemistry staining, the IDH1 status was divided into two groups of mutated-type (IDH1mut) and wild-type (IDH1wild) for each grade. In tumor regions, ADC (apparent diffusion coefficient) and stretched exponential-derived intravoxel heterogeneity index a were extracted to make comparisons between two groups of IDH1mut and IDH1wild for each grade. ROC curve analyses were used to compare the capability of differentiating gliomas of IDH1mut from IDH1wild.

RESULTS

64 grade2gliomas were divided into two groups of IDH1mut (n=41) and IDH1wild (n=23), and 26 grade 3 gliomas were divided into two groups of IDH1mut (n=8) and IDH1wild (n=18). In grade2gliomas, there were significantly increased values of ADC (mm2/s) and a for groups of IDH1mut than IDH1wild (ADC: [1.33±0.322] vs. [1.09±0.232] for IDH1mut (t=3.316, P=0.003) ;a: [0.87±0.054] vs. [0.82±0.050] for IDH1wild (t=3.788, P=0.000). In grade 3, the value of a significantly increased for groups of IDH1mut than IDH1wild (a:[0.83±0.042] for IDH1mut vs. [0.77±0.051] for IDH1wild with P value of 0.008) and no significant difference was shown for ADC ([1.04±0.313] for IDH1mut vs. [0.95±0.154] for IDH1wild with P value of 0.476. ROC analyses showed diagnostic ability of IDHmut for in both grades of gliomas and ADC had the diagnostic ability of IDHmut in grade2gliomas.

CONCLUSION

Non-Gaussian-derived parameter a may identify the status of IDH1 mutation in LGGs with better performance than ADC. In LGG, the water molecules behave more inhomogeneously in groups of IDH1wild than IDH1mut.

CLINICAL RELEVANCE/APPLICATION

The patients with IDH-mutated gliomas can survive much longer than those with IDH non-mutated. Especially for those patients who want conservative treatment and refuse biopsy, they can benefit a lot from non-invasive integrative diagnosis.

SSA17-06 In Vivo Characterization of Macrophages in Adult High Grade Gliomas Using Ferumoxytol-Enhanced MRI

Sunday, Nov. 26 11:35AM - 11:45AM Room: N228

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PURPOSE

Macrophages are a key component of tumor-associated inflammation and play a significant role in angiogenesis, progression, and metastasis as well as in tumor response to therapy. Ferumoxytol-enhanced MRI (feMRI) has been widely used for macrophage imaging in preclinical studies but not in the clinical neuro-oncology setting. The purpose of our study is to establish feMRI as a noninvasive imaging biomarker of macrophages in adults with high grade gliomas (HGGs).

METHOD AND MATERIALS

In this IRB-approved prospective pilot study at an academic institution, adults with newly diagnosed and recurrent HGGs were enrolled. Each patient had an intravenous ferumoxytol infusion (5 mg/kg) and a subsequent MRI (including QSM and R2* maps) performed at least 16 hours later. Two different sites were chosen within each tumor on feMRI for intraoperative sampling. Each sample acquired was stained with a mix of Prussian Blue, CD68, CD163, and GFAP to determine the location of iron and number of iron-containing macrophages per 20 hpf. Using saved images from surgery and Osirix software, ROIs were reproduced at the sampled sites and in the corpus callosum (to normalize the values for each patient) on QSM and R2* maps. Pearson correlation coefficient/regression analysis was used to determine the relationship between QSM and R2* values and number of iron-containing macrophages present.

RESULTS

8 patients (mean age: 58.6 years, range 32-74 years, 5:3 females:males) with HGGs (5 glioblastomas, 1 gliosarcoma, 1 anaplastic astrocytoma, and 1 anaplastic oligodendroglioma) were included in the analysis. On histopathology across all patients, iron particles were only found in CD68+/CD163+ macrophages; none were found elsewhere including GFAP+ glial/astrocytic cells. There were strong, positive correlations that were statistically significant between both the normalized susceptibility (QSM) and R2* values and the number of iron-containing macrophages (r=0.73, p=0.002, for both analyses).

CONCLUSION

Ferumoxytol-enhanced MRI can be used to detect and quantify macrophages in high grade gliomas, with increasing QSM and R2* values strongly correlating with increasing number of iron-containing macrophages.

CLINICAL RELEVANCE/APPLICATION

Ferumoxytol-enhanced MRI with QSM and R2* correlates well with iron-containing macrophages in brain tumors, and this tool can be used as a noninvasive imaging biomarker of tumor-related inflammation.

SSA17-07 Quantitative Study Noninvasively Prediction of Glioma IDH1 Gene Status by APT Combined with ASL Imaging

Sunday, Nov. 26 11:45AM - 11:55AM Room: N228

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PURPOSE

The purpose of this part was to explore whether amide proton transfer (APT) and arterial spin labeling imaging (ASL) helped to noninvasively detect isocitrate dehydrogenase 1 (IDH1) gene status in glioma.

METHOD AND MATERIALS

Patients who suspected glioblastoma underwent APT and ASL examination from December 1, 2014 to October 31, 2016, were prospectively collected. MTRasym (3.5 ppm) values (APT values) and CBF values were measured in the tumor parenchyma region. As the lesional CBF value normalized by contralateral cerebellar hemisphere, the normalized CBF was calculated according to the formula nCBF = CBF tumor / CBF cerebellum. All of the patients had the pathological diagnosis and anti-IDH1 R132H antibody immunohistochemical results. The differences between wild type and mutant IDH1 were analyzed by independent sample t test. The receiver operating characteristic curve (ROC) is used to describe the discriminant image parameters. Calculate the cutting value and sensitivity, specificity.logistics regression analysis combined with the effective parameters of APT and ASL to calculate the overall correct prediction rate.

RESULTS

There were 90 patients with both APT and ASL data. In low-grade glioblastoma, the APT and nCBF values of wild-type IDH1 gene were higher than those of IDH1 mutant group ($p = 0.027$, $p<0.001$). The area under the ROC curve were 0.802, 0.844, when the cutoff was APT = 1.35 (%) and nCBF = 1.74, the sensitivity was 97%, 81.80%, the Specificity was 60.2% and 62.2%. In the high-grade glioma group, the APT and CBF values of IDH1 gene-type glioma were higher than those of IDH1 mutant. The difference was statistically significant ($p = 0.004$, $p = 0.005$); The area under the ROC curve was 0.695 and 0.712, respectively. When the cut value was APT = 3.24 (%), the sensitivity and specificity were 67.4% and 72.2%, respectively. In low-grade glioblastoma, Logistics regression combined with APT values and nCBF values to obtain the overall correct prediction rate is 78.7%; High grade glioma group, combined APT value and CBF value to obtain the overall correct prediction rate is 86.8%.

CONCLUSION

APT and ASL provide a valuable new method for the noninvasive diagnosis of the IDH1 gene state of brain glioma, and the combination of APT and ASL can improve the overall prediction rate of glioma IDH1 gene.

CLINICAL RELEVANCE/APPLICATION

no

SSA17-08 Establishing the Optimal Volumetric Threshold for Determining Progressive Disease in Patients with Recurrent Glioblastoma

Sunday, Nov. 26 11:55AM - 12:05PM Room: N228

Awards
Student Travel Stipend Award

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PURPOSE

Response to treatment in glioblastoma (GBM) is currently measured in 2D. Volumetric methods are potentially more reliable and accurate for assessing progressive disease (PD), but the optimal threshold for assessment for progression has not been established. We investigated the influence of using different thresholds for determining PD for both enhancing and non-enhancing (FLAIR) lesions to predict overall survival (OS) in recurrent GBM.

METHOD AND MATERIALS

Patients were recruited from a phase II-trial (n=148) in which treatment with lomustine and/or bevacizumab was given in first recurrent GBM. Total volume of enhancing and FLAIR lesions was measured separately using Brainlab semi-automated software. Percentage change in volume from baseline to first and second follow-up (6 and 12 weeks) was calculated. The effect of new lesions and of using different thresholds (10-40%) for determining PD was determined with cox regression analyses.

RESULTS

Due to missing MRI-data (3D T1w post-contrast and/or FLAIR-images), a varying number of patients were excluded from the analyses at 6 and 12 weeks (table). Patients with a new lesion at first follow-up (n=12) had significantly worse OS: hazard ratio (HR)=7.63, p<.001. These patients were further not included in the volumetric threshold analyses. At first follow-up, the highest HR was found using 20% increase as a threshold: HR=1.68 (p=.033) for enhancing (n=111) and HR=2.26 (p=.004) for FLAIR lesions (n=90). The presence of a second follow-up scan was associated with significantly improved OS (n=148): HR=3.23, p<.001. At second follow-up, HRs were somewhat higher than at first follow-up, both compared with baseline: HR=1.98 (p=.003) for enhancing (n=109) and HR=2.624 (p<.001) for FLAIR (n=92) lesions.

CONCLUSION

A 20% increase in enhancing or FLAIR volume best predicts OS at 6 weeks follow-up. When change in volume is measured at 12 weeks follow-up, predictions of OS improved, with lower thresholds (10-15%) showing the best results. A 3-month endpoint could therefore be considered in phase II studies on recurrent glioblastoma.

CLINICAL RELEVANCE/APPLICATION

Volumetric tumor measures in glioblastoma could increase accuracy over the current 2D assessment. We investigate the optimum volumetric threshold for determining progressive disease.

SSA17-09 Diffusion Weighted Imaging of Intracranial Hemangiopericytomas

Sunday, Nov. 26 12:05PM - 12:15PM Room: N228

Awards
Student Travel Stipend Award

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PURPOSE

Intracranial Hemangiopericytomas (IHP) are aggressive dural based tumors which are difficult to differentiate from more benign meningiomas. Herein we present the largest series of IHPs to date focusing on MR imaging characteristics to differentiate these tumors from meningiomas.

METHOD AND MATERIALS

Multicenter retrospective review of institutional pathology databases/PACS for cases of IHP (WHO Grade II and III) and meningiomas (WHO Grade I and WHO grade II) from 2005-2016 was performed. Patients without relevant pre-operative MR imaging (T1, T2, DWI and post-contrast T1) were excluded. Imaging evaluation consisted of volumetric analysis, ADC value assessment on diffusion-weighted sequences, and qualitative imaging assessment (T1, T2 and contrast enhancement and presence of flow voids). ADC values were assessed using ROIs (100mm diameter) in the most homogeneous portions of the tumors. ADC values of normal appearing contralateral white matter were used to calculate the ADC-tumor/ADC-white matter ratio. Groups were compared using an unpaired two-tailed student's t-test and one way ANOVA.

RESULTS

Of the 26 patients identified with histologically confirmed IHP, 21 had relevant pre-operative MR imaging for review (14 WHO Grade II, 7 WHO Grade III) and comprised the study population. 48 patients with histologically confirmed WHO Grade I (25) and WHO Grade II (23) meningiomas had relevant pre-operative MR imaging for review and comprised the control population. The study population was 63% male (avg age, 53, range: 22-78) and control population was 52% male (avg age, 55, 20-69). Most IHPs demonstrated flow voids (71%), an uncommon finding in meningiomas (4%) (p<0.01). 57% of IHP tumors demonstrated significantly elevated (ADC-tumor/ADC-normal WM >1.1) ADC ratios. Average ADC-tumor/ADC-WM ratio was 1.26 for IHPs compared to 1.09 for meningiomas (p=0.08). A significant difference between IHPs (ratio:1.26) and WHO Grade I Meningiomas (ratio:1.05) was apparent (p=0.04).

CONCLUSION

This series is the largest to date evaluating the MR imaging characteristics of IHPs. Our findings suggest that IHPs demonstrate

This series is the largest to date evaluating the MR imaging characteristics of IHPs. Our findings suggest that IHPs demonstrate increased diffusivity relative to meningiomas (p=0.08) . The difference is most pronounced between IHPs and WHO grade I meningiomas (p=0.04).

CLINICAL RELEVANCE/APPLICATION

DWI may be a useful diagnostic tool for the radiologist to suggest the diagnosis of intracranial hemangiopericytoma on preoperative MR imaging.

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SSA18

Neuroradiology/Head and Neck (Head and Neck Neoplasms)

Sunday, Nov. 26 10:45AM - 12:15PM Room: N229

CT HN NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSA18-01 NI-RADS Performance on First Post-Treatment FDG-PET/Contrast-Enhanced CT in Head and Neck Squamous Cell Carcinoma to Detect Residual Disease: ROC Analysis of Surgical and Non-Surgical Treatment Groups

Sunday, Nov. 26 10:45AM - 10:55AM Room: N229

Awards
Student Travel Stipend Award

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PURPOSE

The diagnostic performance of the recently published Neck Imaging Reporting & Data System (NI-RADS) for head & neck squamous cell carcinoma (HNSCC) surveillance using post-treatment FDG-PET/Contrast-Enhanced CT (PET/CECT) is undetermined based on treatment type. We aimed to perform a ROC analysis to compare diagnostic performance of NI-RADS for detection of residual disease at both the primary site & in neck nodes in patients with HNSCC treated with either 1) chemoradiation therapy (CRT) alone or 2) surgery +/- CRT.

METHOD AND MATERIALS

A search of an IRB designated quality database for NI-RADS reports on all PET/CECT of the neck from 6/2014 to 7/2016 yielded 418 patients. Inclusion criteria were first time primary HNSCC, a 12- week first post-treatment PET/CECT & a minimum of 9-months of post-treatment follow-up. The electronic health record was reviewed for patient information including treatment modality, pathology results, and clinical and radiologic follow-up. Receiver Operator Curves (ROC) & Area Under Curve (AUC) were derived with 95% confidence intervals. AUCs were compared (Delong method). P-values <0.05 were significant.

RESULTS

Of 182 patients meeting inclusion criteria, 180 primary sites & 182 neck sites were examined. ROC analysis of NI-RADS 1-3 combined performance at the surgically treated primary site +/- CRT (n=82, AUC=0.495, 95% CI: 0.3160.675) vs. CRT alone (n=98, AUC=0.711, 95% CI: 0.5260.897) showed better performance for CRT alone, but no statistical significance (p=0.051). 100% of NI-RADS 3 findings at the primary site were false positives in the surgical arm versus a 50% (4/8) incidence of true disease in the CRT arm. Neck site surgery +/- CRT (n=83, AUC=0.65, 95% CI: 0.3310.969) vs. CRT alone (n=99, AUC=0.726, 95% CI: 0.4331.0) showed no statistical significance (p=0.365).

CONCLUSION

Although the diagnostic performance of NIRADS was not statistically significant different based on treatment arm, there was a trend toward better performance in patients treated with CRT versus surgery +/- CRT at the primary site due to false positives in the NI-RADS 3 category in post-surgical patients.

CLINICAL RELEVANCE/APPLICATION

NI-RADS offers a system of detecting residual HNSCC regardless of treatment type. A larger cohort study is needed to understand the best timing for PET in patients treated with primary resection.

SSA18-02 Amide Proton Transfer (APT) Imaging in Patients with Cervical Lymphadenopathy: Initial Difference between Benignity and Malignancy

Sunday, Nov. 26 10:55AM - 11:05AM Room: N229

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PURPOSE

To depict practical image manifestations of magnetic resonance amide proton transfer (MR-APT) imaging in patients with cervical lymphadenopathy and to reach a profound understanding of the signal changes according to benignity and malignancy, and to discuss its potential clinical applications.

METHOD AND MATERIALS

12 patients (M = 8, average years = 56.1 ± 12.3) with cervical lymphadenopathy were enrolled in this study. They were underwent MRI on the neck. Amide Proton Transfer (APT) images (saturation time 0.8 s, saturation power 2 μT) and Diffusion Weighted Images (DWI) were included in the scanning protocols under 3.0 Tesla MR scanner. APT images were calculated using magnetization transfer ratio asymmetry at 3.5ppm with respect to water. ROIs were drawn along the contour of lymph node with maximum size on the slice consistent with chosen on DWI. APTw values of the lymph nodes in the benign group and the malignant group were compared using two-sample t-test. Pathological results of all the imaged lymph nodes were obtained through fine needle aspiration biopsy.

RESULTS

(1) Malignant lymph nodes (8/12) were metastasis from oropharynx squamous carcinoma and malignant fibrous histiocytoma. (2) MTRasym(3.5ppm) (P=0.003) were showing significant different between benignity (1.91% ± 1.31%) and malignancy (3.69% ± 0.24%). (3) In ROC analysis, its AUC was 0.906 and it was an effective method that the AUC was significantly different from 0.5.

CONCLUSION

APTw could be useful in differentiating benign and malignant lymph nodes.

CLINICAL RELEVANCE/APPLICATION

12 patients with cervical lymphadenopathy underwent MR-APT imaging to differentiate benign and malignant.

SSA18-03 Additive Value of Quantitative CT Texture Analysis of Lymph Nodes for Prognosis Prediction in HPV-Positive Head and Neck Cancers

Sunday, Nov. 26 11:05AM - 11:15AM Room: N229

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PURPOSE

This study aims to characterize the utility of primary tumor and lymph node texture features in predicting disease progression in patients with HPV-positive oropharyngeal squamous cell carcinoma treated with induction chemotherapy.

METHOD AND MATERIALS

Soft-tissue CT images for 35 patients with HPV-positive oropharyngeal squamous cell carcinoma were collected retrospectively under an IRB approved protocol. An experienced radiologist contoured the primary tumor and related lymph nodes in a pre-treatment scan for each patient. Radiomic texture features were automatically calculated from each axial slice of the contoured volumes. Features were selected using stepwise feature selection methods in conjunction with observations from previous studies. Round robin linear discriminant analysis was used to assess feature performance, with the area under the receiver operating characteristic curve (AUC) used as a figure of merit. We investigated the comparative performances of merging RECIST with two primary tumor texture features as well as with an additional two lymph node features.

RESULTS

Based on feature selection, we chose to include the pre-treatment RECIST with tumor energy and entropy, and then with lymph node sum variance and skewness. RECIST with tumor features resulted in an AUC value of 0.64 (se = 0.12) in the task of distinguishing between cases that progressed and those that did not. The combination of RECIST, tumor, and lymph node features yielded an AUC value of 0.72 (se = 0.10).

CONCLUSION

We observed an improvement in the prediction of disease progression when the quantitative texture feature analysis of lymph nodes were included in the predictive signature as compared to a signature with just RECIST and tumor texture information. This was evidenced by an increase in AUC. This is a promising result, and we plan to perform future work to investigate this trend on a larger dataset.

CLINICAL RELEVANCE/APPLICATION

This work aims to study the utility of radiomic features of both tumor and associated lymph nodes in predicting disease progression, which subsequently can help with early diagnosis and personalized care.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Daniel Ginat, MD - 2016 Honored Educator

SSA18-04 Apparent Diffusion Coefficient Histogram and Texture Analysis of Pleomorphic Adenoma and Carcinoma ex Pleomorphic Adenoma of the Salivary Gland

Sunday, Nov. 26 11:15AM - 11:25AM Room: N229

Participants
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PURPOSE

Only subjective mean value measurement with a manual region of interest has been reported for apparent diffusion coefficient (ADC) assessment of salivary gland tumors. The purpose of this study was to investigate the usefulness of whole-tumor ADC histogram and texture analysis for differentiation between pleomorphic adenoma (PA) and carcinoma ex pleomorphic adenoma (CXPA).

METHOD AND MATERIALS

Institutional review board approval was obtained and informed consent was waived due to the retrospective nature of this study. We identified 128 patients with salivary gland tumors who underwent MR imaging and either biopsy or surgery. Patients were as follows: 116 with PA (51 men and 65 women; median age, 52.5 years; age range, 11-84) and 12 with CXPA (10 men and 2 women; mean age, 67 years; age range, 51-82). All images were obtained on the same 1.5 tesla MR scanner with a standard protocol. A blinded radiologist drew volumes of interest on the ADC map covering the entire tumor. The mean, median, minimum, maximum, percentile, standard deviation (SD), kurtosis, skewness, entropy, and uniformity of the ADC value were compared between PA and CXPA groups. A Mann-Whitney U test with false discovery rate control and a receiver operating characteristic (ROC) curve were used for statistical analysis.

RESULTS

The SD ($P = 0.02$) and entropy ($P = 0.02$) were significantly higher in CXPA. Minimum value of ADC ($P = 0.02$), 5th percentile ADC ($P = 0.02$), 10th percentile ADC ($P = 0.04$), and uniformity ($P = 0.02$) were significantly lower in CXPA. Mean ADC ($P = 0.29$) and Median ADC ($P = 0.29$) showed no significant difference. The greatest area under the ROC curve (0.785) was achieved by SD.

CONCLUSION

CXPA showed higher spatial heterogeneity (higher entropy, higher SD, and lower uniformity) of ADC and contained significantly lower value of ADC than PA.

CLINICAL RELEVANCE/APPLICATION

Whole-tumor ADC histogram and texture analysis may be useful for differentiation between PA and CXPA.

SSA18-05 Exploratory Study for Identifying Predictors for Treatment Response of Head and Neck Cancers on CT Using Computerized Analysis

Sunday, Nov. 26 11:25AM - 11:35AM Room: N229

Participants
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PURPOSE

AT-101 is an oral chemotherapeutic agent that induces apoptosis and may be beneficial in laryngeal cancer patients treated with organ preservation therapy. The objective of our study was to investigate the feasibility of using radiomic and perfusion features as predictors of tumor response to AT-101.

METHOD AND MATERIALS

Retrospective analysis of pre and post therapy CT neck scans was performed in 19 patients diagnosed with laryngeal cancer in this IRB approved study. Contouring of the tumors was performed by the computer and tumor features were generated on an internally developed/validated computer-aided detection (CAD) system. Twenty-six radiomic features including morphological and gray-level features were extracted from the computer. Five perfusion features including permeability surface area product (PS), blood flow (flow), blood volume (BV), mean transit time (MTT), and time-to-maximum (Tmax) were extracted from the computer. Post-treatment responses were obtained after one cycle of AT-101 chemotherapy from laryngoscopic exam. A positive response was recorded when there was at least 50% reduction in tumor volume. We performed a two-loop leave one out feature selection using linear discriminant analysis classifier for radiomics alone (2 features). We then took one feature from radiomic and perfusion (2 total) and built a classifier to do a leave-one-out cross-validation. Receiver operator curves and standard deviation were generated.

RESULTS

All 19 lesions examined were primary laryngeal cancers. Out of the 19 patients, there were 7 non-responders (37%) and 12 responders (63%). Selecting two radiomics features alone had an area under the curve (AUC) measuring 0.83 +/- 0.09. Out of all of the features, the best radiomic and perfusion features were the change in contrast enhancement and PS. The best radiomic and perfusion combined improved the AUC to 0.84 +/- 0.9.

CONCLUSION

Our pilot study indicates that radiomic features are good predictors of treatment response with AT-101. The combination of radiomic and perfusion minimally improved prediction. Our next step is to expand our data set with additional available patients.

CLINICAL RELEVANCE/APPLICATION

Predicting treatment response to chemotherapy is an important tool for head and neck cancer management. Good predictors can help providers choose between organ preservation and total laryngectomy.

SSA18-06 Diagnostic Performance of Simultaneous [18F] FDG PET/MR in Comparison with PET or MR Alone in Head and Neck Cancer

Sunday, Nov. 26 11:35AM - 11:45AM Room: N229

Participants
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PURPOSE

Although the benefits of PET/CT have been established in patients with head and neck malignancy, the usefulness of the recently introduced PET/MR has not been elucidated. The purpose of this study was to compare the diagnostic performance of simultaneous PET/MR with PET or MR alone in depicting malignant lesions in the head and neck.

METHOD AND MATERIALS

Seventy three patients (47 men, 26 women; mean age, 58 years; age range, 18-83 years) who underwent simultaneous PET/MR for diagnostic work-up of malignancy in head and neck were enrolled in this retrospective study. For 134 lesions (72 primary sites vs. 62 nodal levels; 79 for initial workup vs. 55 for recurrence workup) that were confirmed by pathology (n=111) and clinical follow-up (n=23), MR and PET images were retrospectively and independently reviewed, blinded to the clinical data. Subsequently, simultaneous PET/MR images were evaluated by consensus of the two readers. Area under the receiver operating characteristic curve, sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were obtained and compared among PET, MR, and simultaneous PET/MR.

RESULTS

Area under the ROC curve (AUC) of simultaneous PET/MR per lesion (0.93) and per patient (0.93) for depiction of malignancy in the head and neck were significantly higher than PET (0.85 and 0.75, respectively) or MR (0.84 and 0.80, respectively) alone ($P < .05$). AUC of PET/MR for initial workup (0.89) and for recurrence workup (0.99) tended to be higher than PET (0.83 and 0.85, respectively) and MR (0.81 and 0.86) ($P<0.05$ except for $P=0.08$ in comparison between PET/MR and PET for initial workup). AUC of PET/MR for primary sites (0.93) was higher than PET (0.73) and that for nodal levels (0.93) was higher than MR (0.80) ($P<0.05$). Thirty percent of indefinite MR ratings were placed in a definitive category (score 1 or 5) after consensus. In this series, simultaneous PET/MR had a sensitivity of 87%, a specificity of 92%, a positive predictive value of 92%, a negative predictive value

of 87%, and an accuracy of 90%.

CONCLUSION

Simultaneous PET/MR shows better diagnostic performance compared with PET or MR alone for the evaluation of malignancy in the head and neck.

CLINICAL RELEVANCE/APPLICATION

In patients with head and neck cancer, PET/MR shows better diagnostic performance compared with PET or MR alone, whether for initial or recurrence workup, or whether for primary sites or nodal levels.

SSA18-07 Intravoxel Incoherent Motion MR Imaging in the Differentiation of Benign from Malignant Sinonasal Lesions: Comparison with Conventional Diffusion-Weighted MR Imaging

Sunday, Nov. 26 11:45AM - 11:55AM Room: N229

Participants
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PURPOSE

This study aimed to evaluate intravoxel incoherent motion MR imaging (IVIM) in the differentiation between benign and malignant sinonasal lesions, and to compare the diagnostic performance of IVIM with conventional diffusion-weighted MR imaging (DWI).

METHOD AND MATERIALS

131 patients with histopathologically confirmed solid sinonasal lesions (56 benign and 75 malignant) who underwent conventional MRI, DWI, and IVIM were enrolled in this study. D, D* and f values derived from IVIM, as well as ADC value derived from conventional DWI, were measured and compared between the two groups using independent samples t-tests. The sensitivity, specificity, accuracy, positive predictive values (PPV), negative predictive values (NPV), and the area under the receiver operating characteristic (ROC) curve were determined.

RESULTS

The mean ADC and D values were significantly lower in the malignant sinonasal lesions than those in the benign sinonasal lesions (both $p < 0.001$). The mean f value was significantly higher in the malignant lesions than in the benign lesions ($p = 0.007$). The area under the curve of D value was significantly larger than that of ADC and f value (0.981 versus 0.725 and 0.641, respectively; both $p < 0.001$). The cutoff value of <= 0.887 for D value provided sensitivity, specificity, and accuracy of 98.7%, 96.4% and 97.7%, respectively, for differentiating benign from malignant sinonasal lesions.

CONCLUSION

IVIM appears to be a more efficient MR technique compared with conventional DWI in the differentiation between benign and malignant sinonasal lesions.

CLINICAL RELEVANCE/APPLICATION

D value from IVIM demonstrated significantly higher accuracy compared with ADC value for the differentiation of benign from malignant sinonasal lesions. Therefore, IVIM appears to be efficient MR technique for a possible method to evaluate the sinonasal lesions.

SSA18-08 Spectral Dual Energy CT Texture Analysis for the Evaluation and Characterization of Cervical Lymphadenopathy

Sunday, Nov. 26 11:55AM - 12:05PM Room: N229

Awards
Student Travel Stipend Award

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PURPOSE

To determine whether spectral dual energy CT (DECT) texture analysis can be used to identify and differentiate metastatic nodes from head and neck squamous cell carcinoma (HNSCC), nodal involvement by lymphoma, or inflammatory nodes from normal lymph nodes.

METHOD AND MATERIALS

DECT scans of the neck from 50 patients were reviewed, 10 from each of the following groups, with multiple nodes per patient contoured for texture analysis (shown in parentheses): normal (40), inflammatory (29), lymphoma (65), HNSCC with metastatic adenopathy (31), and HNSCC with benign lymph nodes (40). For HNSCC, only patients with pathological confirmation based on lymph node dissection (positive or negative) were included. Metastatic HNSCC nodes were compared to unaffected nodes from HNSCC patients without metastatic lymphadenopathy based on neck dissection. Lymphoma and inflammatory nodes were compared to a population of normal neck scans without history of cancer or other systemic disease. Texture analysis was performed using a commercial software (TexRAD®) by manually delineating a region of interest around the largest diameter of the lymph node on VMIs ranging from 40 to 140 keV in 5 keV increments. Random forests (RF) models were constructed using various histogram-based texture features for outcome prediction with internal cross-validation in addition to use of separate randomly selected training and validation sets. Sensitivity (Sens), specificity (Spec), positive predictive value (PPV), and negative predictive value (NPV) were calculated for node classification.

RESULTS

Metastatic HNSCC nodes could be differentiated from normal nodes with a Sens, Spec, PPV, and NPV of 100%, 91%, 90%, and 100%, respectively. Sens, Spec, PPV, and NPV was 100%, 92%, 95%, and 100% for differentiating nodal involvement by lymphoma from normal nodes and 88%, 83%, 78%, and 91% for differentiating inflammatory nodes from normal nodes, respectively.

CONCLUSION

Spectral texture analysis of lymph nodes can distinguish different pathologic lymph nodes from normal nodes with a high accuracy.

CLINICAL RELEVANCE/APPLICATION

DECT texture analysis of lymph nodes may be used in radiomic models to increase accuracy for the determination and characterization of pathologic lymph nodes in the neck.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Caroline Reinhold, MD, MSc - 2013 Honored EducatorCaroline Reinhold, MD, MSc - 2014 Honored EducatorCaroline Reinhold, MD, MSc - 2017 Honored Educator

SSA18-09 Ultrasound-Guided Fine Needle Aspiration with Optional Core Needle Biopsy of Head and Neck Lymph Nodes and Masses: Comparison of Diagnostic Performance in Squamous Cell Cancer with Residual Masses after Therapy versus All Other Lesions

Sunday, Nov. 26 12:05PM - 12:15PM Room: N229

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To evaluate the diagnostic performance of ultrasound-guided fine needle aspiration (FNA) with optional core needle biopsy (CNB) of head and neck lymph nodes and masses, with attention to differences between biopsy of squamous cell carcinoma (SCC) with a residual mass after radiation or combined chemotherapy/radiation therapy and biopsy of other lesions.

METHOD AND MATERIALS

IRB approval was obtained and the need for consent was waived for this retrospective study. All 1957 ultrasound guided biopsies of head and neck lesions performed by the ultrasound service at our institution between 3/1/2012 and 5/16/2016 were reviewed. Thyroid biopsies, salivary gland biopsies, and fluid aspirations were excluded. In 843 of 861 procedures, the biopsy procedure began with an FNA and preliminary interpretation of the sample by a cytopathologist. CNB was then added in 210 cases, if considered indicated and technically feasible. In 18 cases, only CNB was performed, mostly following a recent FNA performed by another service.

RESULTS

861 biopsies of head and neck lymph nodes and masses were included; 53 targeted SCC with residual masses after treatment. The biopsy procedures yielded definitively benign or malignant results in 71.7% (38/53) of treated SCC and in 90.8% (733/807) of all other lesions ($p<0.001$). A reference standard based on subsequent pathology or clinical and imaging follow-up was established in 68.6% of procedures. In cases with definitive benign or malignant biopsy results and a subsequent reference standard, sensitivity for malignancy was 88.2% (95% CI, 65.7% - 96.7%) in treated SCC and 98.3% (96.0% - 99.3%) in all other cases ($p=0.052$) and specificity was 63.6% (35.4% - 84.8%) in treated SCC and 99.5% (97.3% - 99.9%) in all other cases ($p<0.001$). There were no significant complications related to the biopsy procedures.

CONCLUSION

Ultrasound-guided needle biopsy of head and neck SCC with a residual mass after therapy has significant limitations in specimen

adequacy, sensitivity and specificity. Otherwise, ultrasound-guided FNA with optional CNB of head and neck lymph nodes and masses has excellent diagnostic performance.

CLINICAL RELEVANCE/APPLICATION

Ultrasound-guided FNA with optional CNB of head/neck nodes and masses has excellent diagnostic performance, but results should be interpreted with caution in SCC with a residual mass after therapy.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
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SSA19

Neuroradiology (Dots and Dashes: Image Analysis in Neuroradiology)

Sunday, Nov. 26 10:45AM - 12:15PM Room: N230B

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credits: 1.50

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSA19-01 Enhancing the T1-weighted Template: Tissue Probability Maps and Gray Matter Labels of the IIT Human Brain Atlas

Sunday, Nov. 26 10:45AM - 10:55AM Room: N230B

Participants
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PURPOSE

The IIT Human Brain Atlas contains anatomical, DTI, HARDI templates, probabilistic gray matter (GM) labels, probabilistic connectivity-based white matter (WM) labels, and major fiber-bundles of the young adult human brain. The purpose of this work was to enhance the quality of the T1-weighted template, tissue probability maps, and GM labels of the IIT Human Brain Atlas.

METHOD AND MATERIALS

The same T1-weighted data from the 72 healthy volunteers included in the previous version of the IIT Human Brain Atlas (v.4.1) were used in the construction of the new resources. The T1-weighted image-volume of each participant was transformed from native space to the space of the existing T1-weighted template. Then, the volumes were normalized following two constraints, one for the intensity, and one for the transformation. The spatial transformations generated above were combined to a single transformation, which was then applied to the corresponding data for each participant: raw T1-weighted data, raw segmented tissue masks (GM, WM, and CSF), and raw segmented labels (90 cortical and subcortical regions). Next, the T1-weighted data from all participants were averaged to generate the new T1-weighted template. New tissue probability maps, probability maps for each label and a confidence index map for the GM labeling were also generated and compared to those of the existing atlas.

RESULTS

The new T1-weighted template is of higher sharpness (according to the high spatial frequency content), and has lower noise than the existing template. The new tissue probability maps exhibit better definition of GM, WM, and CSF than the existing ones. The new GM labels show greater confidence in GM labeling.

CONCLUSION

In this work, the T1-weighted template, tissue probability maps and GM labels of the IIT Human Brain Atlas were substantially enhanced. The IIT Human Brain Atlas with its comprehensive set of resources located in the same space, are expected to increase the accuracy of multi-modal studies, as well as conventional investigations on brain macrostructure.

CLINICAL RELEVANCE/APPLICATION

The enhanced IIT Human Brain Atlas is expected to increase the accuracy of multi-modal MRI studies.

SSA19-02 Synthetic Contrast Enhancement Map Using Post-Contrast MR Quantification Only

Sunday, Nov. 26 10:55AM - 11:05AM Room: N230B

Participants
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PURPOSE

Administration of Gadolinium contrast medium is an important diagnostic tool to detect blood-brain-barrier damage. In clinical practice the use of GD, however, is time-consuming because both a native and post-contrast image must be acquired. It is possible to omit the native image, but this reduces diagnostic confidence, especially for anatomically complex areas. For quantification of GD-enhancement image registration is challenging. The purpose of this study was to investigate the possibility to synthesize a GD-enhancement map solely from the post-GD image, using quantitative MRI.

METHOD AND MATERIALS

In brain parenchyma there is a relation between proton density PD and the longitudinal R1 relaxation rate. For every 1% decrease of PD signal, the R1 increases with 0.03 s-1 (3T). This relation is affected when GD contrast media is present in the tissue, since R1 increases, while PD remain the same. A simultaneous measurement of post-GD PD and R1 therefore provides means of calculating the difference in R1 due to GD compared to the expected native R1 based on the PD values. For 10 patients with malignant glioma grade 4, MR quantification was performed both before and after contrast administration. The acquisition was a MAGiC sequence on a GE 750 3T system with a scan time of 6 minutes. Post-processing was performed using SyMRI 8.0 (SyntheticMR, Sweden). The two image stacks were registered using in-plane transformation. The R1 maps were subtracted to obtain the true GD-enhancement map. This was correlated with the synthetic GD-enhancement map, created using the post-GD R1 and PD maps only.

RESULTS

Linear regression of the true and synthetic GD-enhancement map for the 10 subjects showed a mean slope of 1.15±0.21 and mean intercept of 0.02±0.14. The Pearson correlation coefficient was 0.856±0.05.

CONCLUSION

The study shows that it is possible to synthesize a GD-enhancement map based on a post-GD MR quantification sequence only.

CLINICAL RELEVANCE/APPLICATION

A GD-enhancement map based on a post-GD acquisition only may permit omission of a native T1W, resulting in a substantial time saving. Without time pressure for GD uptake, it may even lead to lower GD doses.

SSA19-03 Correlation of Quantitative Analysis on Three-Dimensional Fluid-Attenuated Inversion Recovery (3D-FLAIR) and Contrast-Enhanced FLAIR with Auditory Test in Meniere's Disease

Sunday, Nov. 26 11:05AM - 11:15AM Room: N230B

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PURPOSE

This study was aimed to assess the prognostic value of quantitative analyses of cochlear signal intensity(SI) using Three-Dimensional Fluid-Attenuated Inversion Recovery (3D-FLAIR) MRI and Contrast-Enhanced (CE)- FLAIR MRI, and designed to correlate cochlear ROI with degree of hearing decrease in patients with Meniere's disease.

METHOD AND MATERIALS

132 patients underwent 3 Tesla (3T) MRI of the temporal area for MD over 3-year period. 3D-FLAIR sequence imaging and CE-FLAIR were included on temporal MRI. Signal intensity was measured by drawing region of interest (ROI) in membranous labyrinth of cochlea and quantitatively analyzed. Measured cochlear signal intensity was compared with available clinical findings, speech audiometry and pure tone audiometry test (PTA). Patients had typical results of auditory testing for Meniere's disease.

RESULTS

There was statistical significance of patient's sex with 3D-FLAIR ($p < .05$) and CE-FLAIR ($p < .01$). Cochlear ROI in symptomatic ear side showed significant statistical significance on both FLAIR and enhanced FLAIR ($p < .0001$). There was statistical significance of increase of cochlear SI on 3D-FLAIR and CE-FLAIR with pretreatment PTA of hearing loss ($P < .0001$). There was no statistical significance between prognosis and cochlear SI of FLAIR and CE-FLAIR. There was no statistical significance of PTA change with contrast enhancement index and contrast enhancement ratio. The optimal cut off value of SI increase on FLAIR was 20.8 (sensitivity, 64%; specificity, 66%; AUC, 72.9) and on enhanced FLAIR was 30.4 (sensitivity, 66%; specificity, 68%; AUC, 72.8) between asymptomatic ear and symptomatic ear.

CONCLUSION

Quantitative analysis of ROI on MR imaging data does not confer a benefit to predict the prognosis of Meniere's disease. However, increased signal intensity and inner ear enhancement of 3D FLAIR are helpful diagnostic markers for Meniere's disease.

CLINICAL RELEVANCE/APPLICATION

Increased cochlear ROI on 3D-FLAIR and enhanced FLAIR MRI provide an ideal diagnostic evidences in the sudden sensory neural hearing loss patients.

SSA19-05 Can MR Textural Analysis Improve Detection of Extracapsular Nodal Spread in Patients with Oral Cavity Cancer: A Feasibility Study

Sunday, Nov. 26 11:25AM - 11:35AM Room: N230B

Awards
Student Travel Stipend Award

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PURPOSE

To explore the utility of MR texture analysis (MRTA) for detection of extracapsular nodal spread (ECS) in oral cavity squamous cell carcinoma (SCC).

METHOD AND MATERIALS

30 patients with node-positive oral cavity SCC treated surgically in a single center were evaluated. 15/30 (50%) had pathologic evidence of ECS. 2 experienced radiologists independently reviewed baseline MRI blinded to histology. Presence/absence of MR features associated with ECS (flare sign, irregular capsular contour; local infiltration; nodal necrosis) were agreed in consensus. Regions of interest (ROI) encompassing largest nodal cross-sectional area were defined on T2 and post-contrast T1-weighted images. First-order texture parameters (entropy, skewness and kurtosis) were extracted from the ROIs using proprietary software (TexRAD) with fine (2mm), medium (4 mm) and coarse (6 mm) filters. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of MR predictors of ECS were compared with histology as gold standard. MRTA performance in predicting ECS was assessed using paired t-test. Areas under the curve (AUC) calculated by receiver operating characteristics (ROC) analysis and optimal threshold were calculated for texture parameters.

RESULTS

Sensitivity, specificity, PPV and NPV (%) for MR predictors were: flare sign 85.7, 93.3, 85.7, 93.3; irregular capsular contour 53.3, 86.7, 80, 65; local infiltration 26.7, 86.7, 66.7, 54.2; nodal necrosis 73.3, 46.7, 57.9, 63.6. Nodal entropy had a statistically significant correlation with ECS on T2 imaging independent of filtration level, highest with coarse nodal entropy (N6, $p = 0.02$). AUC for entropy N6 was 0.77, sensitivity 73.3%, specificity 80%, PPV 76.7%, NPV 73.3% with a threshold > 6.12.

CONCLUSION

First-order texture parameters (entropy) extracted from T2-weighted MRI may improve ECS prediction in oral cavity SCC.

CLINICAL RELEVANCE/APPLICATION

Extracapsular nodal spread (ECS) is associated with adverse prognosis in oral cavity squamous cell carcinoma and may alter planned treatment. MR texture analysis may increase pre-treatment detection of ECS but requires further validation.

SSA19-06 Multiresolution Texture Processing of T2-weighted MRI May Reveal Lesion Pathology in Multiple Sclerosis

Sunday, Nov. 26 11:35AM - 11:45AM Room: N230B

Participants
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PURPOSE

Focal lesions remain the hallmark pathology of multiple sclerosis (MS), however, MRI lesion burden correlates only modestly to patient disability due to the lack of lesion specificity. We hypothesize that advanced image post-processing techniques can help extract latent lesion pathology from standard MR images.

METHOD AND MATERIALS

1.5:T T2-weighted MR images acquired from 5 postmortem multiple sclerosis patients were post-processed using advanced texture analysis. Histologically proven lesion types were examined by severity: active or chronic active (demyelinated with variable inflammation), versus pre-active (inflammation only) or shadow plaques. A total of 13 lesions and 20 controls were used in a classification experiment, with a subsample of the ventricles included for comparison.Using the polar Stockwell transform, we generated two spectral density maps for each of the 10x256x256 pixels in the data set: one radial and one angular. Borrowing from the chemometrics literature, we used principal component analysis to estimate the dominant textures in the dataset. Anatomical features, control white matter, and MS lesions were hypothesized to be realizations of these textures. Using quadratic discrimination analysis, we categorized regions of interest based on 7 of these dominant textures (99.9% of variance).

RESULTS

Our results indicate that different lesion subtypes show distinct MRI texture (Fig.:1), which also differs from the surrounding tissue. Overall, our method was 88% accurate (212/240) in classifying the pathological severity of tissue types.

CONCLUSION

This pilot study suggests that novel image analysis techniques have the potential to detect the type of lesion pathology concealed in clinical MRI. Lesions with both demyelination and inflammation showed different texture than lesions with either pathology alone.

CLINICAL RELEVANCE/APPLICATION

This new technique can be applied to patient images routinely collected in clinical practice, and has the potential to advance our ability to monitor disease progression and treatment response.

SSA19-07 Radiomics Features of MR Imaging as Prognostic Factors in Locally Advanced Head and Neck Squamous Cell Carcinoma

Sunday, Nov. 26 11:45AM - 11:55AM Room: N230B

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PURPOSE

Radiomics refers to the comprehensive quantification of tumor phenotypes by applying a large number of quantitative image features. The current study was to identify pre-treatment T2-weighted imaging (T2WI)-based radiomics as prognostic factors in patients with locally advanced head and neck squamous cell carcinoma (HNSCC).

METHOD AND MATERIALS

This study consisted of 119 patients with stage III- IVb HNSCC. A total of 485 radiomics features were extracted. Least absolute shrinkage and selection operator (LASSO) regression model was used for data dimension reduction and feature selection. Association between the radiomics signature and overall survival (OS) was explored. Further validation of the radiomics signature as an independent biomarker was performed by using multivariate Cox regression. Multivariate models were built for overall survival (OS) using only clinical factors, and combined clinical factors and pretreatment radiomics signature. To quantify the incremental value of the radiomics signature to the traditional staging system and other clinical factors, Harrell's C-index was measured.

RESULTS

Clinical factors of sex and AJCC stage were statistically associated with OS of patients, respectively. The radiomics signature, which consisted of 7 selected features, was significantly associated with OS, independent of clinical risk factors ($P<0.001$). Incorporating the radiomics signature with sex and stage resulted in better performance (C-index: 0.70; 95% confidence interval [CI]: 0.63, 0.76) for the prediction of OS than using sex and stage alone (C-index: 0.63; 95% CI: 0.54, 0.73) ($P=0.003$).

CONCLUSION

The radiomics signature is an independent biomarker for OS estimation of patients with locally advanced HNSCC. Combination of the radiomics signature with clinical factors significantly improves the predictive performance of clinical factors alone.

CLINICAL RELEVANCE/APPLICATION

The current study was to explore the potential of pre-treatment T2-weighted imaging (T2WI)-based radiomics as prognostic factors in patients with locally advanced head and neck squamous cell carcinoma (HNSCC). A 7-feature-radiomics signature was developed proved to be an independent biomarker for OS estimation of patients with locally advanced HNSCC. Combination of the radiomics signature with clinical factors significantly improves the predictive performance of clinical factors alone.

SSA19-08 Fusion MR Imaging: A Fast One Stop Shopping Tool for Diagnosis and Characterization of Vestibular and Intralabyrinthine Schwannomas

Sunday, Nov. 26 11:55AM - 12:05PM Room: N230B

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PURPOSE

To prove the technical feasibility of fusing heavily T2-weighted 3D turbo spin-echo (SPACE) and contrast-enhanced T1-weighted 3D (MPRAGE) datasets and to determine reading time to final diagnosis and diagnostic accuracy in patients with suspected

vestibular or intralabyrinthine schwannomas.

METHOD AND MATERIALS

53 patients were evaluated. Two radiologists specialized in ENT with 10 and 14 years of experience evaluated 3D T2 and post Gd T1 images and fusion sequences in consensus as the reference standard. For the evaluation of reading time and diagnostic accuracy two groups of two less experienced radiologists (residents in 3rd-4th year of training) were formed. Group 1 evaluated 3D T2 and Gd T1 images seperately, group 2 read the fused images only. Image quality was assessed based on a 5-point-scale (1 = highest confidence to 5 = diagnosis not possible). Interobserver agreement was calculated using Cohen`s kappa.

RESULTS

Fused images yielded significantly faster reading times (39.5 ± 28.5 s vs. 67.5 ± 34.5 s; p <= 0.001) compared to conventional separate reading of both 3D T2 and T1 sequences in all cases. Image quality of fused images was rated significantly better by all readers (p <= 0.05) with higher diagnostic accuracy (fusion images: sensitivity 100%; specifity 90-100% vs. conventional group: sensitivity 100%; specifity 88-94%). Interobserver agreement according to recognized lesion was excellent (0.87-1.0).

CONCLUSION

Fused images of high-resolution 3D heavily T2-weighted and contrast-enhanced T1-weighted images allow for faster detection and more precise characterization of vestibular and intralabyrinthine schwannomas.

CLINICAL RELEVANCE/APPLICATION

The possibility of displaying the fluid-filled architecture of the cerebellopontine angle and the inner ear by 3D T2-weighted MR imaging combined with contrast enhanced T1-weighted MPRAGE is helpful to improve radiologist workflow and increase diagnostic accuracy and efficiency to detect even small targets that are difficult to delineate especially in the inner ear in usual examination.

SSA19-09 CT Imaging of Periocular Metallic Foreign Bodies Can be Improved by Artifact Reduction Software

Sunday, Nov. 26 12:05PM - 12:15PM Room: N230B

Participants
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PURPOSE

Computed tomography (CT) is the standard of care for the assessment of ocular and orbital trauma, however, streak artifacts due to retained metallic foreign bodies (FB) can limit the utility of CT. We hypothesize that implementation of metal artifact reduction techniques could improve image quality and diagnostic confidence for a diverse group of interpreters regardless of experience or specialty.

METHOD AND MATERIALS

Ten cases of retained periocular metallic foreign bodies which were noted on CT scan were identified retrospectively from a large urban trauma center. Post-acquisition images were processed with metal streak artifact reduction (MAR) software. The change in the severity of the metal streak artifact was assessed quantitatively by 1) the size of the artifact and 2) the standard deviation of pixel intensities along a path surrounding the foreign body. For subjective assessment, radiologists (4), ophthalmologists (4) and oculoplastic specialists (3) used a Likert scale to grade images on 6 different clinically relevant criteria.

RESULTS

The standard deviation of pixel intensity for a path surrounding the FB as well as the area of the streak artifact was decreased in all cases (p<0.001, paired t-test). Human grading of overall confidence in diagnosis and severity of metallic streak was improved with MAR (p<0.001, Wilcoxon signed-rank test). Similarly, the confidence of assessment of specific structures - including identification of FB, extra-ocular muscles, optic nerve, ruptured globe and orbital fracture -- was improved after MAR (p<0.001, Wilcoxon signed-rank test) but to various degrees in each case.

CONCLUSION

Postprocessing metal artifact reduction algorithms in computed tomography of the orbit can improve image quality by decreasing streak artifact as well as increase interpreter confidence in assessing vital anatomical structures in cases of orbital trauma.

CLINICAL RELEVANCE/APPLICATION

Metal artifact reduction algorithms in computed tomography has potential benefits in improving diagnostic accuracy and confidence in periocular trauma cases.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSA20

Physics (CT: Photon Counting and Spectral CT)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S403B

CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSA20-01 Multi-Material Decomposition of Iodine Mixed with Potential High-Z Contrast Agents in Energy Discriminating Photon Counting Computed Tomography

Sunday, Nov. 26 10:45AM - 10:55AM Room: S403B

Participants
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PURPOSE

To evaluate the quality of a quantitative image-based multi-material decomposition algorithm on mixtures of potential CT contrast agents (CA) for Photon Counting Detector CT (PCD-CT) technology.

METHOD AND MATERIALS

CT-images were obtained using a PCD-CT research scanner (SOMATOM CounT, Siemens Healthcare GmbH, Forchheim). Three tube voltages were applied: 100, 120, and 140 kV using 160, 120, and 80 mAs, respectively. All CT images were acquired using four energy thresholds: 25, 45, 65, and 80 keV. Three mixtures of aqueous solutions of iodine and a high-Z CA, either Gadolinium (Gd), Hafnium (Hf) or Tungsten (W), were investigated. They were placed into vials arranged around the center of a cylindrical 20 cm wide water-equivalent phantom. Both a two and a three material decomposition, including water as a third base material, were applied to the reconstructed energy threshold images. Identical measurements were repeated 15 times to determine average concentrations and the systematic deviation. The statistical errors were assessed by the evaluation of the dose normalized standard deviations of the measured concentrations.

RESULTS

When decomposing into two base materials the measured concentrations deviated from the known values from -0.5 mg/mL to 0.5 mg/mL. The overall best performance was observed for the differentiation of I and Hf using the 140 kV x-ray spectrum and the given energy thresholds (0.1 mg/mL and 0.0 mg/mL deviation for I and Hf, respectively). By adding water as a third base material, the systematic deviations increased to a range from -2.7 mg/mL to 1.8 mg/mL. Separation into I, water and either Gd or Hf provided more accurate results due to their better energy separation when compared to I, water and W, where especially water and W showed similar attenuation over all selected energies.

CONCLUSION

For the selected x-ray spectra and energy thresholds, the two-material decompositions provided good results with absolute deviations from the known concentrations under 0.5 mg/mL. By adding water as a third base material the accuracy of the decomposition decreased, especially with tungsten at 100 kV due to its similar spectral characteristics to water at this configuration.

CLINICAL RELEVANCE/APPLICATION

To separate and quantify mixed CA solutions using image data from a single PCD-CT scan

SSA20-02 Differentiation between Blood and Iodine in a Bovine Brain: Initial Experience with Spectral Photon-Counting CT

Sunday, Nov. 26 10:55AM - 11:05AM Room: S403B

Participants

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PURPOSE

To evaluate the potential of the Spectral Photon-Counting CT (SPCCT) for the differentiation between blood and iodine in a bovine brain.

METHOD AND MATERIALS

First, in vitro experiment using tubes with blood and different concentrations of iodine-based contrast material were scanned with a preclinical SPCCT system to obtain spectral and conventional data. Second, tubes with (a) blood and (b) iodine-based contrast material were positioned within a bovine brain. Iodine maps and virtual non-contrast images were generated using the multibin spectral information to perform material decomposition. Region of interest (ROI) analysis were performed within the tubes to quantitatively determine the absolute content of iodine.

RESULTS

In the conventional CT images, ROI analysis showed similar HU density values for the tube with blood and iodine (59.9 +/- 1.8 versus 59.2. +/- 1.5). Iodine maps enabled clear differentiation between blood and iodine in vitro as well as in the bovine brain. Quantitative measurements of the tubes with different iodine concentrations matched well with those of actual prepared mixtures.

CONCLUSION

Spectral Photon-Counting CT enables differentiation between blood and iodine in vitro and within a bovine brain, and quantification of different iodine concentrations is feasible.

CLINICAL RELEVANCE/APPLICATION

Spectral Photon-Counting CT providing iodine maps and virtual non-contrast images allows for material decomposition and reliable quantification of different iodine concentrations.

SSA20-03 Gold Nanoparticle-Based Contrast-Enhanced CT in a Large Animal Model of Renal Artery Stenosis Using a Whole Body Photon-Counting CT System

Sunday, Nov. 26 11:05AM - 11:15AM Room: S403B

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PURPOSE

To evaluate, in phantoms and in a swine model of renal artery stenosis (RAS), the performance of a photon-counting CT (PCCT) system for quantification of targeted-gold nanoparticles (AuNPs).

METHOD AND MATERIALS

We used a whole-body PCCT system (Siemens Healthcare, Germany) to image phantoms and a swine with induced RAS. AuNPs (bare size = 20 nm) were synthesized using gold chloride solution (10% HAuCl4.3H20) and 5% sodium citrate dihydrate. Collagen-1 antibody conjugated PEG-coated AuNPs (45 nm) were made to target tissue fibrosis. RAS was induced in a pig by placing a local-irritant coil in the main renal artery for 6 weeks. A 20 cm water phantom with iodine (4, 8, 10 mg/mL) and AuNPs (2, 4, 6 mg/mL) solutions was scanned to assess material quantification accuracy. Renal artery angiography of the pig was performed to assess the degree of stenosis using iodinated contrast (Omnipaque, GE Healthcare Inc.), followed by PCCT scans (T = 0: no AuNPs, and T=1: 20 mL intra-renal injection of 20mg/mL AuNPs). All scans were performed at 120 kVp, 550mAs (CTDIvol = 47.8 mGy) with energy thresholds 25, 48, 65 and 75 keV. Images were reconstructed using filtered backprojection and a quantitative, medium-smooth kernel (D30). Prototype software (eXamine, Siemens Healthcare, Germany) was used for material quantification of targeted-AuNPs and residual iodine from renal angiography.

RESULTS

Regression analysis revealed a close linear relationship (R2 =0.95) between the measured and true AuNP densities in the phantom. AuNPs at 2, 4 and 6 mg/mL were estimated at 2.2, 3.5 and 6.3 mg/mL respectively. In the swine images, ROI analysis showed a CT number enhancement of approximately 76 HU within the injected stenotic kidney cortex and medulla, while a circular ROI in the paraspinal muscle showed a mean CT number of 60 HU.

CONCLUSION

We evaluated the performance of PCCT and material quantification for multi-contrast imaging, specifically, measuring CT number enhancement induced by low concentrations of AuNPs. We have demonstrated for the first time in vivo imaging of AuNPs in a large animal model using a whole-body PCCT system, albeit the signal magnitude at the current level of development is challenging.

CLINICAL RELEVANCE/APPLICATION

Gold nanoparticles can be tailored for molecular imaging, targeting certain tissue-types and organs thereby enabling novel applications of PCCT in diagnosis and treatment assessment.

SSA20-04 Spectral Ultra-High Resolution Coronary Stent Imaging with Photon-Counting CT: Initial Experience

Sunday, Nov. 26 11:15AM - 11:25AM Room: S403B

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PURPOSE

To evaluate the performance of an ultra-high resolution (UHR) spectral photon-counting detector (PCD) computed tomography (CT) system for coronary stent imaging and to compare the results to conventional energy-integrating detector (EID) CT.

METHOD AND MATERIALS

Coronary stents with different diameters (2.0-4.0 mm) were examined inside a coronary artery phantom consisting of plastic tubes filled with iodine-based contrast material diluted to approximate clinical concentrations (450 HU). EID images were acquired using 2nd and 3rd generation dual-source CT systems (SOMATOM Flash and SOMATOM Force, Siemens Healthcare) at 0.60 mm isotropic voxel size. Radiation-dose matched PCD images were acquired using a prototype ultra-high resolution PCD system (Siemens Healthcare) at standard 0.50 mm and ultra-high 0.25 mm isotropic resolution. Images were reconstructed using optimized convolution kernels. Image quality of EID versus PCD for stent diameter visualization was compared using one-way analysis of variance and Wilcoxon signed-rank test. Paired t-test was used to compare the accuracy of spectral PCD iodine quantification in the presence or absence of the highly attenuating stents.

RESULTS

UHR PCD images significantly improved stent lumen visualization (78.2±9.6%) over EID Flash, EID Force, and standard resolution PCD images (52.5±12.6%, 56.8±12.5%, and 60.3±12.3%, respectively, all $P<0.01$). Stent lumen visualization improved with larger stent sizes for all image series ($P<0.05$ Pearson correlation). Spectral PCD iodine imaging enabled visualization of the coronary artery lumen without interference from the coronary stent or plastic tube. PCD iodine quantification was similar in the presence or absence of the coronary stents (23.0±1.7 mM vs 22.9±0.9 mM, $P=0.81$), suggesting robustness of material decomposition to beam hardening artifacts.

CONCLUSION

Ultra-high resolution PCD CT may significantly improve coronary stent lumen visualization over conventional CT due to reduced blooming artifacts with the added advantage of providing spectral information that may be used for material decomposition.

CLINICAL RELEVANCE/APPLICATION

Improved coronary stent lumen visualization with ultra-high resolution PCD CT may allow for improved non-invasive diagnosis of stent malapposition and in-stent restenosis.

SSA20-05 Image based Material Decomposition with Material Map De-noising using Photon Counting Computed Tomography (PCCT)

Sunday, Nov. 26 11:25AM - 11:35AM Room: S403B

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PURPOSE

To develop and validate a new image based material decomposition method using non-local means (NLM) and alternating direction method of multipliers (ADMM).

METHOD AND MATERIALS

Image based material decomposition was formulated as minimization of an objective function consisting of a data fidelity and a NLM-based regularization term. The optimization problem was solved with ADMM. The method was evaluated using simulations, phantom and animal studies. Vials containing various concentrations of iron chloride and sodium chloride solutions were used in simulations. For phantom studies, vials containing calcium chloride and iohexol solutions were placed in a 20 cm water phantom and scanned on a whole-body PCCT scanner (CounT, Siemens Healthcare). Material decomposition was performed using denoised images and results were compared to the reference concentrations. In addition, a female swine was scanned on the PCCT scanner with 140 kV, 4 energy thresholds (25, 45, 65, 85 keV), 140mAs, 32x0.5 mm collimation and 15.5 mGy CTDIvol (matched to clinical dose level). Performance of the proposed method was compared to a least squares (LS) based decomposition method using original and denoised images.

RESULTS

A linear relationship was observed between measured and reference concentrations (R2>=0.93) using the proposed method. Compared to the LS method (with and without denoising), it showed more uniform appearance and less noise in all three studies. In simulations, the proposed method had 90, 91, and 91% reduction of root mean square errors (RMSE) in the Fe, Na and water concentration measurements compared to the LS method, and 27, 31 and 29% reduction compared to the LS method with denoising. In the phantom study, the RMSE in the Ca, I and water concentrations were reduced by 90, 89 and 78%, and 17, 14, and 4% of LS without and with denoising, respectively.

CONCLUSION

Simulation and phantom studies quantitatively demonstrated that the proposed method provided accurate material specific images with low image noise. The advantage of the proposed method was further confirmed in the in-vivo swine study, where the patchy appearance of LS method with denoising in the material specific images was decreased with proposed method.

CLINICAL RELEVANCE/APPLICATION

The proposed method provides accurate and low noise material specific images using PCCT multi-energy imaging at clinical dose levels.

SSA20-06 Efficient and Accurate Spectral Distortion Compensation for Photon Counting CT via Low-Rank Approximation-Based X-Ray Transmittance Modeling

Sunday, Nov. 26 11:35AM - 11:45AM Room: S403B

Participants
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PURPOSE

Photon counting detectors (PCDs) provide spectral sensitivity with energy windows; however, the measured spectrum is distorted due to charge sharing and fluorescent x-ray emission. These spectral distortions can be compensated for to improve material decomposition accuracy. Thus, the aim of this study was to develop a method that is more computationally efficient than maximum likelihood (ML) estimator, while it is also as accurate and precise as ML is.

METHOD AND MATERIALS

We have developed a method that works on each of sinogram point independently and efficiently. The spectral distortion model was incorporated as the imaging chain, which related the incident x-ray spectrum to the attenuation due to the object (which is called "x-ray transmittance") to the output of PCD. The non-linear x-ray transmittance was modeled by a set of energy-dependent basis curves via the low-rank approximation, and the coefficients of the basis curves, which were linearly related to the PCD output, were efficiently estimated by solving the linear minimization problem. Thorough and systematic computer simulations were performed to assess the performance of the proposed method.

RESULTS

We have performed two types of computer simulations with two objects. The first object consisted of soft tissue and bone, whereas the second object added gadolinium to the first object. Many combinations of different thicknesses of multiple materials were examined. The computational efficiency of the proposed method was found to be orders of magnitude faster than ML with non-negativity constraint (ML+) (0.22 min versus 1,056.8 min). The bias of the proposed method was smaller than the ML and ML+. The noise of the proposed method was comparable to Cramer Rao lower bound (CRLB) and slightly larger than that of ML+. The reconstructed K-edge images showed streaking artifacts due to the bias with ML+, whereas accurate results with the proposed method.

CONCLUSION

We have developed a method, which is computationally efficient, can compensate for the spectral distortion more effectively than ML or ML+, and has noise level that is comparable to CRLB.

CLINICAL RELEVANCE/APPLICATION

Efficient and effective spectral distortion compensation is the key to the direct characterization of tissues and lesions, which is expected to be an important feature of PCD-CT.

SSA20-07 First Evaluation of New Photon Counting Technology for Cardiac CT

Sunday, Nov. 26 11:45AM - 11:55AM Room: S403B

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PURPOSE

We are developing a novel photon-counting detector with 8 energy bins and 0.2x0.3mm^2 pixels at the isocentre for high-resolution clinical computed tomography (CT) imaging. We present the first images of excised human hearts that were scanned using our detector technology, showing improved visibility of arterial plaque and iodine compared to the current state of the art. In addition, we demonstrate the feasibility of projection-based, three-material basis decomposition for cardiac CT based on measurements acquired with the new detector technology.

METHOD AND MATERIALS

Post-mortem human hearts from five individuals were staged and imaged using a spectrally resolved photon counting detector made of crystalline Silicon. The hearts were sliced axially and then mounted in a 3D-printed model to preserve the anatomical structure and facilitate imaging despite different scanning orientations. Coronary arteries that were cut were closed with 6-0 sutures and the lumen filled with gelatine containing iodine to obtain relevant Hounsfield Unit contrast. Reconstructed CT images from the photon counting system were compared to those acquired using three state-of-the-art clinical CT scanners at the Karolinska University Hospital. We compared the visibility and separation of arterial plaque and iodine. In addition, we performed projection-based three-material basis material decomposition using recent developments in forward-model calibration - not currently possible with dual-energy clinical CT systems.

RESULTS

The results demonstrate improved spatial and spectral resolution, compared to state-of-the-art. Specifically, we demonstrate increased visibility and separation of arterial plaque and iodine. In addition, unbiased iodine basis material images are presented.

CONCLUSION

Several excised human hearts have successfully been imaged using a novel photon-counting spectrally resolved detector with sub-millimetre spatial resolution. Compared to current state of the art, reconstructed CT images demonstrate improved spatial and spectral resolution, which may improve CT applications such as cardiac imaging.

CLINICAL RELEVANCE/APPLICATION

High-resolution CT with enhanced spectral capability may benefit cardiac imaging by improving quantitation in calcium scoring due to reduction of blooming artefacts, visualization in coronary CT angiography, and perfusion analysis due to improved detection of iodine and unbiased material-specific imaging.

SSA20-08 Anisotropic Denoising for Material Decomposition from Spectral Photon-Counting CT: Application to Human Blood Iron Level Estimation

Sunday, Nov. 26 11:55AM - 12:05PM Room: S403B

Awards
Trainee Research Prize - Fellow

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PURPOSE

To develop a radiation dose-efficient image-based material decomposition technique for spectral photon-counting CT (PCCT) data and to investigate estimating human blood iron concentration from contrast-enhanced (CE) scans.

METHOD AND MATERIALS

We adapt the well-known anisotropic denoising (AD) approach for simultaneous denoising and decomposition of spectral PCCT images. Unlike the standard pixel-by-pixel approach, AD regularizes the solution using similarity weights between neighboring pixels.

We tailor AD for PCCT in two ways. First, to ensure accuracy, we employ a *guided* similarity calculation, using the image created from all detected photons, regardless of their spectral bin, to calculate weights. We assume the all-photon image contains all the edge information of the spectral bins but is less noisy. Second, we incorporate the linear generative model directly into the anisotropic equation, simultaneously estimating concentration maps of all pixels from spectral bins. AD only requires a large and sparse linear system to solve, with one parameter for the filter weight.

RESULTS

We test AD on 4-energy threshold spectral PCCT scans of a human subject pre- and post-contrast. The decomposition method was calibrated using vials of known concentrations of iodine and Fe solutions placed under the patient. The vials were also used to calculate the precision and bias of AD. The blood iron content of the CE scan was estimated and compared to that of the pre-contrast scan. Within the vials, AD estimates remain stable while reducing noise SD by 56% and 54% for iron and iodine, respectively. This suggests over 4x decrease in radiation. Aortic iron concentration measured from AD had small bias, but with a noise reduction of 67.8%. The small bias (-5%) in CE Fe content may be attributed to the blood volume increase after injection.

CONCLUSION

The dose-efficient AD decomposition method shows improved precision over the standard approach in estimating blood-iron concentration. Future work will include additional human studies to determine the optimal tradeoff between precision and algorithmic bias.

CLINICAL RELEVANCE/APPLICATION

This algorithm can provide higher quality concentration maps from spectral photon-counting CT, improving estimation of blood-iron content in addition to iodine concentration.

SSA20-09 Applied Quantitative Multi-Material Decomposition Using Photon Counting Detector CT (PDC-CT) Image Data

Sunday, Nov. 26 12:05PM - 12:15PM Room: S403B

Participants
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PURPOSE

To apply and evaluate an image based decomposition algorithm on three and four materials using single scan multi-energy projection data acquired by a research photon counting detector CT (PCD-CT) system.

METHOD AND MATERIALS

Six solutions of contrast agents (CAs) in concentrations of 5 and 10 mg/mL were investigated: zirconium (Zr), iodine (I), gadolinium (Gd), dysprosium (Dy), hafnium (Hf), and tungsten (W). The K-edges of all materials lay in the energy range for clinical CT. Multi-energy CT-images were obtained from eight different combinations of sets of three CAs. The solutions, each filled into a 2 cm wide vial, were arranged in an equiangular fashion inside a 20 cm diameter water-equivalent phantom. All CT-images were acquired using a PCD-CT research system (SOMATOM CounT, Siemens Healthcare GmbH, Forchheim) with tube voltages of 100, 120, or 140 kV and respective tube current-time-products of 160, 120, 80 mAs. Four energy thresholds were applied: 25, 45, 65, and 80 keV. The reconstructed energy-threshold images were decomposed into concentration images of three or four materials. For the first case, the respective materials of the investigated set of CAs were chosen as base materials, for the second case, water was additionally included as a base material. The resulting accuracies were determined by comparing the extracted concentration values to the corresponding known values.

RESULTS

The CAs could be differentiated and quantified in all investigated cases. The mean deviations of the measured concentrations were 8% for 100 kV, 3% for 120 kV, and 9% for 140 kV. The two different concentrations provided linear proportionality in CT-values. CAs with similar x-ray attenuation characteristics showed resembling enhancements throughout the single spectral images and showed greater deviations from the anticipated concentration values (up to -34% for separation of I, Hf, W, and water at 120 kV).

CONCLUSION

An image-based multi-material decomposition algorithm was applied on CT-data of a PCD-CT research system. The measured concentrations of different CAs showed good correspondence to their known concentrations. The quality of the material separations depend on the selected base materials, the number of base materials, the applied x-ray tube voltage and the selected energy thresholds.

CLINICAL RELEVANCE/APPLICATION

To demonstrate feasibility of applying and separating multiple contrast agents within a single PCD-CT scan.

SSA21

Physics (CT: New Techniques)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S404AB

CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Cynthia H. McCollough, PhD, Rochester, MN (*Moderator*) Research Grant, Siemens AG
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Sub-Events

SSA21-01 Potential Application of Photon Counting Detector CT in Intracranial Hemorrhage Detection

Sunday, Nov. 26 10:45AM - 10:55AM Room: S404AB

Awards
Trainee Research Prize - Medical Student

Participants
Xu Ji, Madison, WI (*Presenter*) Nothing to Disclose
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PURPOSE

Detection and monitoring of intracranial hemorrhage (ICH) is crucial for the management and treatment of acute strokes. When endovascular stroke therapy is performed in the angiography suite, there is often a need for intraoperative ICH imaging, which currently is performed using C-arm CBCT with a flat panel detector (FPD). However, the performance of CBCT for detecting low contrast ICH may be severely limited. The purpose of this work was to study the potential of a photon counting detector (PCD)-based CT system for reliable ICH imaging.

METHOD AND MATERIALS

The PCD-CT system used a CdTe-based PCD with 100 µm pixel size, 50 cm transverse coverage, 150 fps maximal readout speed, >75% MTF@ 2 lp/mm, >50% DQE(f) @2 lp/mm, and negligible lag. Other major components of the PCD-CT include a rotating-anode diagnostic tube, 0.2 mm Cu beam filter, and a bowtie filter. The maximal field of view of the system is 41 cm. An anthropomorphic head phantom with a simulated ICH (diameter=0.8 cm, nominal contrast=10 HU) in the right hemisphere and contrast-enhanced cerebral arteries in the left hemisphere was imaged using both the PCD-CT and a state-of-the-art MDCT. The tube potential (80 kV), radiation dose (CTDIvol=17 mGy), slice thickness (5 mm), image pixel size (0.4 mm), and image display W/L were matched between the two CT systems. Images of the phantom were evaluated quantitatively using the CNR of the ICH and subjectively in terms of brain tissue-CSF differentiation, image sharpness, and noise texture.

RESULTS

The small, low contrast ICH was clearly visible in the PCD-CT image. The measured CNR of the ICH was 3.1 for PCD-CT and 2.9 for MDCT. The PCD-CT reconstructions demonstrated a much finer noise texture compared with the MDCT images, and edges of the ICH and small vessels were sharper in PCD-CT. The boundary between brain tissue and CSF was well defined by PCD-CT.

CONCLUSION

The feasibility of intracranial hemorrhage detection using PCD-CT was demonstrated. Initial phantom studies demonstrate that image quality and detection performance for low contrast ICH using the PCD-CT can match clinical MDCT.

CLINICAL RELEVANCE/APPLICATION

The presented PCD-CT system has the potential to address the limited low contrast sensitivity of FPD-based CBCT in assessing the risk of ICH prior to and during endovascular stroke therapy.

SSA21-02 Impact of Tube Voltage (kV) Selection on Spectral-Based Coronary CTA Calcium Plaque Removal for Photon Counting Detector CT (PCD-CT)

Sunday, Nov. 26 10:55AM - 11:05AM Room: S404AB

Participants
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PURPOSE

Previous studies demonstrated the feasibility of removing calcified plaques from coronary CT angiograms (CTA) using spectral data. For PCD-CT, higher kV increases spectral performance, whereas lower kV improves iodine visualization in coronary vessels. Our aim was to evaluate the influence of kV selection on vessel iodine contrast, noise and quality of spectral-based calcified plaque removal.

METHOD AND MATERIALS

Four anthropomorphic vessel phantoms simulating coronary arteries (Ø 4 mm) with different combinations of iodine enhancement (500 and 800 HU at 120 kV) and three degrees of calcified stenosis (25, 50 and 75%) & calcium densities (400 and 800 mgHA/cm³) were used in this study. To simulate patient attenuation, an anthropomorphic chest phantom was used. CT images were acquired using a PCD-CT research scanner (SOMATOM CounT, Siemens, Germany). For various dose levels (CTDIvol: 8 to 32 mGy) and four tube voltages (80 to 140 kV), high and low energy bin images were obtained. Images were processed using a modified three material decomposition to separate the data into calcium, soft tissue, and iodine maps. Mixed images, images without coronary calcium and calcium-only images were generated. Iodine enhancement (CT values) and noise (STDEV) were recorded. Quality of the calcium removal was evaluated quantitatively and visually.

RESULTS

For the same dose level, tube voltage minimally influenced image noise. However, for all dose levels, lower tube voltage did result in higher iodine CT values. For example, lumen contrast was 682 HU, 763 HU and 898 HU at 140 kV, 120 kV and 100 kV, respectively. Plaque removal performed better for higher concentrations of iodine and higher densities of calcium. 120 kV and 140 kV led to similar calcium removal quality, whereas the plaque surface appeared fringed at 80 kV and 100 kV due to reduced spectral separation.

CONCLUSION

Removal of calcified plaques using spectral information is feasible irrespective of the selected tube voltage for PCT-CT. However, a substantial improvement in plaque removal quality was observed at 120 and 140 kV. Of these, 120 kV revealed increased vessel contrast.

CLINICAL RELEVANCE/APPLICATION

Reliable removal of calcified plaque in coronary CTA imaging may allow for reduced exam series and more accurate diagnoses.

SSA21-03 Potential of Photon Counting Technique for Next-Generation Type X-Ray Diagnostic System: To Provide New Medical Image Concerning Effective Atomic Numbers Using Plain X-Ray

Sunday, Nov. 26 11:05AM - 11:15AM Room: S404AB

Participants
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TEACHING POINTS

1) Photon counting technique enables the production of a diagnostic X-ray image in which the effective atomic number can be precisely determined. 2) The beam hardening effect should be corrected in order to achieve precise analysis even when a part of the X-ray spectrum is analyzed.

TABLE OF CONTENTS/OUTLINE

1) Aim We aim to propose a novel material identification method based on a photon counting technique. In this system, X-ray spectrum penetrating an object is measured pixel by pixel. Each pixel has the potential to derive material composition of an object. 2) Materials and Methods We proposed a novel method. By dividing the X-ray spectrum into two energy bins, and attenuation factors of the object were calculated. In addition, we proposed a beam hardening correction procedure, which can be applied to two energy bins. The following studies were performed; 1) theory construction, 2) verification experiment using single-probe-type CdTe detector, 3) Monte-Carlo simulation, and 4) demonstration of obtaining a two dimensional X-ray image using a test imaging system. 3) Result and Discussion Our method can determine effective atomic number with an accuracy of +/-0.1 Z under actual clinical conditions during plain X-ray diagnosis. In addition to the traditional X-ray image, effective atomic number image enables precise diagnosis.

PDF UPLOAD

https://abstract.rsna.org/uploads/2017/17004368/17004368_fnrr.pdf

SSA21-04 Assessment of Spatial Resolution in Coronary Stents using Photon-Counting CT Detector: An In-vitro Study

Sunday, Nov. 26 11:15AM - 11:25AM Room: S404AB

Participants
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PURPOSE

To investigate computed tomography (CT) imaging characteristics of coronary stents using a novel photon counting detector (PCD) in comparison with a conventional energy-integrating detector (EID).

METHOD AND MATERIALS

In this in-vitro study, 18 different coronary stents were expanded in plastic tubes of 3 mm diameter, were filled with diluted contrast agent (300mg/ml) and were sealed. Stents were placed in an oil-filled custom phantom calibrated to an attenuation of -100HU for resembling pericardial fat. The phantom was positioned in the gantry at 2 different angles at 0° and 90° relative to the z-axis and were imaged in a 128-section research dual-source PCD-CT scanner. Detector subsystem "A" used a standard EID, while detector subsystem "B" used a PCD allowing high resolution scanning at two energy thresholds. Images were obtained at identical tube voltage and tube current and were reconstructed using the identical sharp-tissue convolution kernel (B46f). Two independent, blinded readers evaluated in-stent visibility, measured noise, intraluminal stent diameter, and in-stent attenuation for each detector subsystem. Differences in noise, intraluminal stent diameter, and in-stent attenuation where tested using a paired t-test; differences in subjective in-stent visibility were evaluated using a Wilcoxon signed-rank test.

RESULTS

Subjective in-stent visibility was superior in coronary stent images obtained from PCD, compared to EID ($p<0.001$). The mean intraluminal stent diameter was 22.9% greater in PCD (0.85 ±0.24 mm) compared to EID image acquisition (0.66 ±0.21 mm; $p<0.001$). Average noise was significantly lower ($p<0.001$) for PCD (5±0.2 HU) compared to EID (8.3±0.2 HU). In-stent attenuation values were significantly lower for PCD (125.8±77.6 HU) compared to EID (193.5±140.9 HU) ($p=0.001$).

CONCLUSION

Use of PCD in CT imaging of coronary artery stents yields superior spatial resolution compared to CT scanners equipped with conventional EID at a matched dose.

CLINICAL RELEVANCE/APPLICATION

PCD-CT imaging has superior spatial resolution compared to images obtained with a conventional EID-CT at a matched dose, which improves the in-stent lumen visualization of coronary artery stents.

SSA21-05 Image Quality Assessment and Dose-Efficiency of Quarter-Millimeter Photon-Counting CT of Humans: First In Vivo Experience

Sunday, Nov. 26 11:25AM - 11:35AM Room: S404AB

Participants
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PURPOSE

Current methods of UHR acquisition rely on a the highly dose-inefficient UHR comb that blocks ½ to ¾ of the surface of the detector in order to increase spatial resolution. We investigated the image quality of 0.25mm, ultra-high resolution (UHR) photon-counting detector CT (PCD-CT) acquisition and reconstructions in human subjects. PCDs directly convert x-ray photons into electric pulses and their pixels can be made very small because PCDs do not include scintillating crystals and therefore do not suffer from their physical limitations.

METHOD AND MATERIALS

8 volunteers received brain and lung scans in spiral standard resolution (SR) and axial UHR modes on a whole-body prototype PCD-CT scanner; lungs: 140 kVp, 110 mAs, brain: 120 kVp, 370 mAs. Filtered backprojection reconstructions were made at 0.5 mm isotropic voxel size for SR and UHR data and 0.25 mm isotropic size for UHR data. Noise power spectrum was measured in a 20-cm water-equivalent phantom; image standard deviation was measured in large uniform ROIs in the volunteers. Image resolution was measured in the line pair section of the Catphan CT phantom. HU accuracy was measured in a water phantom with 25 inserts of materials of known concentrations.

RESULTS

UHR acquisition reconstructed at 0.25 mm improved image resolution from 9 to 19 LP/cm, with 70% noise increase compared to dose-matched SR acquisition. Interestingly, UHR acquisitions reconstructed at 0.5 mm resolution showed 20% less noise compared to SR images at 0.5 mm, confirmed both in phantom and human measurements. This can be attributed to the reduced noise aliasing due to higher sampling rate of noise in UHR acquisitions. There was no significant bias in the HU values measured in SR and UHR: confidence interval= [-4.6 4.8] HU.

CONCLUSION

0.25-mm PCD acquisition has two advantages: 1- ultrahigh resolution images at acceptable dose levels compared to UHR comb scans (2.8x vs 16x). 2- lower-noise images (20%) when reconstructed at SR voxel sizes, leading to potentially 36% reduction in radiation dose while maintaining image quality.

CLINICAL RELEVANCE/APPLICATION

Ultrahigh-resolution PCD CT markedly improves spatial resolution (19 LP/cm); at standard (0.5 mm) resolution, radiation dose of PCD CT would decrease by 36% compared to conventional detectors.

SSA21-06 Feasibility of Auto-ECG-Gating Technique of 256 Row CT Coronary Angiography in Patients without Heart Rate Control

Sunday, Nov. 26 11:35AM - 11:45AM Room: S404AB

Participants
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PURPOSE

To investigate the feasibility of CT coronary angiography (CCTA) in patients without heart rate control by optimizing the acquisition phase with auto-ECG-gating technology on a 256-row detector CT.

METHOD AND MATERIALS

Total 200 patients with suspected coronary artery disease were enrolled and underwent CCTA with auto-ECG-gating on a 256 row wide detector CT (Revolution CT). Patients were divided into four groups according to the real-time heart rate (HR), group A (50 patients): HR<= 69 bpm; group B (50 patients): HR 70 to 80 bpm; group C (50 patients): HR 81 to 90 bpm; group D: HR>= 91 bpm. The image quality and diagnostic interpretability were accessed by two experienced radiologists blindly with likert 4-point score. The images quality score, diagnostic interpretability and radiation dose were compared with one-way ANOVA or rank sum test among 4 groups.

RESULTS

There were no significant difference of age, sex, and body mass index among four groups, and there was significant difference of image quality score among 4 groups (all $P<0.05$). Total 800 coronary arteries and 2575 segments were assessed. There were no significant differences of diagnostic interpretability among four groups derived from the segment, coronary artery and patients ($P>0.05$). The effective radiation dose in A-D groups were (1.05±0.48)mSv,(2.41±1.20)mSv,(1.27±0.55)mSv, (2.66±1.12)mSv($F=29.22$,$P< 0.001$) respectively.

CONCLUSION

It is feasible to perform CCTA in single cardiac cycle in patient without heart rate control by auto-ECG-gating using Revolution CT equipped wide-volume detector.

CLINICAL RELEVANCE/APPLICATION

CCTA can be performed in patients with high heart rate through auto-ECG-gating technology on a 256-row wide-volume detector with low radiation dose.

SSA21-07 Ultimate Pulmonary Imaging: Leading-edge Ultra-High Resolution CT vs Conventional Area Detector CT

Sunday, Nov. 26 11:45AM - 11:55AM Room: S404AB

Participants
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PURPOSE

To compare the image quality between leading-edge ultra-high resolution CT (U-HRCT) and conventional area detector CT (AD-CT).

METHOD AND MATERIALS

Eleven cadaveric lungs were scanned by both U-HRCT (Aquilion Precision™;Toshiba) and AD-CT (Aquilion ONE™;Toshiba). Each cadaveric lung was scanned at 3 different position levels. U-HRCT images were obtained with a 1.5 sec-gantry rotation, 16cm field

of view, and 120kV. Three types of modes were scanned: Normal mode (U-HRCT*N*:Detector element[DM], 896channel, 0.5mmx80row; matrix, 512; pitch factor[PF], 0.81; CTDI, 23.2mGy); Super High Resolution mode (U-HRCT*SR*:DM, 1792channel, 0.25mmx160row; matrix, 1024; PF, 0.81; CTDI, 23.2mGy); and Volume mode (U-HRCT*SR-VOL*: non-helical scan with U-HRCT*SR*; CTDI, 19.2mGy). AD-CT images were obtained with the same conditions of U-HRCT*N* (CTDI, 23.9mGy). All CT images reconstructed at 0.5mm slice thickness were graded on a 3-point scale (1=worse,2=equal,3=better) by 3 independent observers, compared with U-HRCT*N*: 1) Normal CT findings (vessel, bronchi); 2) Abnormal CT findings (ground-glass opacity, consolidation, emphysema, faint and solid nodules, interlobular septal thickening, intralobular reticular opacity, bronchiectasis, honeycombing); 3) Other CT findings (noise, artifacts [streak, dark band], overall image quality). Median scores were used as final evaluations. Noise values were calculated by measuring the standard deviation values in a circular region of interest placed on each selected image. Statistical analysis was performed using Friedman test followed by post-hoc tests.

RESULTS

Both U-HRCT*SR* and U-HRCT*SR-VOL* improved normal and abnormal CT findings and reduced streak and dark band artifacts significantly more than AD-CT($p<0.014$). U-HRCT*SR-VOL* improved a visual noise better than U-HRCT*SR* and AD-CT($p<0.00001$). Quantitative noise values were significantly higher in order of U-HRCT*SR*(median, 29.5), U-HRCT*SR-VOL* (26.2), AD-CT(15.9), and U-HRCT*N*(14.2)($p<0.0001$). U-HRCT*SR* and U-HRCT*SR-VOL* significantly provided higher overall image quality than AD-CT almost equal to U-HRCT*N*($p<0.0001$).

CONCLUSION

U-HRCT*SR* and U-HRCT*SR-VOL* can provide higher image quality than AD-CT. U-HRCT*SR-VOL* is also more advantageous in noise than U-HRCT*SR*.

CLINICAL RELEVANCE/APPLICATION

U-HRCT*SR* and U-HRCT*SR-VOL* might contribute more detailed evaluations in lung by substantially improving image quality than AD-CT.

SSA21-08 Reducing Pseudo Enhancement of Liver Cyst with Virtual Monochromatic Spectral Images: A Clinical Application Study

Sunday, Nov. 26 11:55AM - 12:05PM Room: S404AB

Participants
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PURPOSE

To evaluate the clinical value of using virtual monochromatic spectral (VMS) images to reduce pseudo-enhancement of liver cysts.

METHOD AND MATERIALS

10 patients with a total of 26 small liver cysts (the long diameter of less than 2 cm) who underwent enhanced spectral CT scans were included. Lesions were confirmed by the combination of ultrasound, MR and multi-phase abdominal spectral CT imaging to be liver cyst. Plain CT, contrast enhanced spectral CT scans in cortical phase (25-30s delay) and portal venous phase (60-70s delay) were performed. The 140kVp polychromatic images and 70keV VMS image of 1.25mm and 5mm thickness were reconstructed in the cortical phase and portal venous phase. CT number difference between the enhanced-phase image and the pre-contrast image was calculated, and the enhancement (pseudo) was assumed when the CT number difference was greater than the historical value of 10HU. The 140kVp polychromatic image was used as a reference to represent conventional CT imaging condition.

RESULTS

The minimum and maximum diameters of the 26 cysts were 4.7mm and 19.5mm, respectively. Using the 140kVp polychromatic image, one observed 5 and 14 pseudo-enhanced cysts in the cortical phase and portal venous phase, respectively in the 5mm slice images; and 3 and 8 cases of pseudo-enhancement in the 1.25mm slice images. The pseudo enhancement was greatly reduced to 3 and 7 cases for the 5mm slice thickness and 2 and 3 cases for the 1.25mm slice in the cortical phase and cortico-medullary phase, respectively when the 70keV VMS images were used. The total number of pseudo enhancement in the 5mm slice polychromatic images (19) was markedly reduced to 11 with the use of 1.25mm slice images ($P=0.08$), and was further reduced to 5 when the 70keV VMS images of 1.25mm thin slice was used ($P=0.001$).

CONCLUSION

The pseudo enhancement of small liver cysts existed based on the CT number threshold and influenced by image thickness. Compared with conventional polychromatic and thick slice mode, virtual monochromatic spectral images in its thin slice form can considerably reduce the phenomenon of small liver cysts pseudo-enhancement.

CLINICAL RELEVANCE/APPLICATION

Thin slice virtual monochromatic spectral images can greatly reduce the phenomenon of pseudo enhancement of small liver cysts. They have a role in identifying real enhancement characteristics of lesions.

SSA21-09 Comparison of X-Ray Phase Contrast CT at a Synchrotron Facility with Conventional Imaging Modalities on Wrists

Sunday, Nov. 26 12:05PM - 12:15PM Room: S404AB

Participants
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PURPOSE

None of the current conventional medical imaging approaches permit to visualize and differentiate in a single image all the different tissues of a joint. For instance, X-ray absorption based Computed Tomography (CT) shows limitations for the imaging parts presenting a weak density. Although Magnetic Resonance Imaging (MRI) is crucial for soft tissue it struggles to render properly the bony changes using conventional routine sequences. Phase Contrast Imaging (PCI) takes advantage of the dual properties of the X-rays to reveal sample enhanced details of simultaneously soft and hard materials. This work presents qualitative comparison between PCI using Propagation Based Imaging CT and today's conventional medical imaging modalities (CT/MRI/US).

METHOD AND MATERIALS

PCI images were acquired using a monochromatic X-ray beam whose energy was set to 60:keV (22 µm voxel size). The sample and the detector were positioned 11:m apart. The qualitative image comparison was carried out based on 3 cadaveric human wrists. The samples were maintained fixed in dedicated containers filled with formaldehyde.

RESULTS

The results show higher image quality in PCI data sets compared to conventional clinical multi-modality imaging. Equivalently to conventional MRI routine sequence, PCI images offer good contrast for the soft tissues. In addition, spongy lamellar bone tissues are also better rendered with PCI than with clinical CT, making details of the trabeculae visible. The PCI superiority in terms of both resolution and contrast helps to differentiate the various components such as the cartilages, ligaments and muscles. The figure presents axial right wrist images reconstructed from (a) conventional CT, (b) PCI CT on a synchrotron source (b) and (c) MRI T2 sequence

CONCLUSION

This proof of concept experiment demonstrates the potential of the PCI in terms of image quality. This pre-clinical study lets foresee a widespread use of coherent X-ray sources for medical imaging in a near future. In this context, new of under development compact X-ray technologies are watched with interest.

CLINICAL RELEVANCE/APPLICATION

This study provides a comparative study of synchrotron Phase Contrast Imaging CT of wrists with hospital conventional imaging modalities (CT/MRI/US).

SSA22

Physics (MR: Applications)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S405AB

MR PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Stephen J. Riederer, PhD, Rochester, MN (*Moderator*) Nothing to Disclose

Sub-Events

SSA22-01 Reproducibility of GABA in Occipital Lobe in Healthy Subjects Employing Mega-press at 3T

Sunday, Nov. 26 10:45AM - 10:55AM Room: S405AB

Participants
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PURPOSE

To evaluate the reproducibility of γ-aminobutyric acid (GABA) in occipital lobe of normal subjects at 3T.

METHOD AND MATERIALS

Spectroscopic data were acquired from occipital lobe region in 16 normal adult volunteers (9 males and 7 females; mean age: 23.5±1.3) using J-editing technique and MEGA-PRESS pulse sequence (the sequence was developed on the platform of Siemens MR system, TR/TE=2000 ms /68 ms, VOI=25×25×25 mm3, BW=1200 Hz, Measurements=320, the editing pulses applied at 1.9 ppm or 7.5 ppm in an interleaved manner) at a 3T scanner, and each subject scanned twice (duration between scans: 7 days). The GABA data divided into three groups, Visit1, for the first scan, Visit2, for the second scan, and Visit1&2, for the first and second scans, respectively. The reproducibility of GABA was assessed by the GABA+/NAA ratio, coefficient of variation (CV) and t-test.

RESULTS

The mean GABA+/NAA ratio in the two scans of each subject was ranged from 0.179 to 0.283 (Fig. 1), during which the CVs were below 10% in eleven subjects. The mean GABA+/NAA ratios of different groups were similar, and with the CVs below 15% (Tab. 1). The t-test result showed that the two scans of all subjects had no significant difference (p=0.480). The mean GABA+/NAA ratio of male group were higher than that of female group, however, the CVs of male group were lower than that of female group (Tab. 2). In addition, the t-test results also suggested that the two scans of both the two groups had no significant difference (p=0.280, p=0.973). However, significant difference was found in the mean GABA+/NAA ratios between the two groups (p=0.022).

CONCLUSION

The measurements of GABA in occipital lobe demonstrated a good reproducibility in healthy volunteers with J-editing technique and MEGA-PRESS pulse sequence at 3T, and the mean relative concentration is higher in male than that in female.

CLINICAL RELEVANCE/APPLICATION

Detection of GABA in occipital lobe demonstrated a good reproducibility in healthy volunteers with J-editing technique and MEGA-PRESS pulse sequence is recommended in the evaluation of human brain GABA concentration.

SSA22-02 Quality Assurance of Diffusion Weighted Imaging: Comparison of a New ACR Phantom Based Method with the QIBA Method

Sunday, Nov. 26 10:55AM - 11:05AM Room: S405AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Quality Assurance (QA) of diffusion weighted imaging (DWI) as recommended by the RSNA Quantitative Imaging Biomarkers Alliance (QIBA) requires a special ice water phantom that is not widely available and difficult to prepare. The ACR phantom, however, is available in many clinical MRI facilities and used for weekly QA. Therefore, it would be beneficial to develop a DWI QA procedure based on the ACR phantom (ACR DWI QA) that can be integrated into the weekly QA. The purpose of this work is to develop such a method and compare with the QIBA method.

METHOD AND MATERIALS

QIBA DWI QA was performed according to QIBA protocol (http://qibawiki.rsna.org/). For ACR DWI QA, the following adjustments were made: TR=5000ms due to a shorter T1, and averages of 2, 2, 4 and 8 for b=0, 500, 900 and 2000 s/mm2 to improve the SNR. The temperature of the ACR phantom was measured pre-/post-scan with a laser thermometer [Dr. Meter IR-20] (accuracy<1°C). Comparison of QIBA and ACR DWI QA was performed on two different scanners: 1) a Siemens 3T Prisma using a 20ch head&neck coil and 2) a GE 3T MR750 using an 8ch head coil. Apparent Diffusion Coefficient (ADC) maps were generated by the built-in software on the scanners. The mean ADC value in three different ROIs as shown in fig. 1 were averaged and compared against the theoretical value described by Holz et al. 2000 (PCCP) at the measured temperature to determine the deviation of ADC.

RESULTS

The mean deviation of ADC based on ACR DWI QA was 0.89% (SD±0.71%) for scanner 1 and 2.55% (SD±0.62%) for scanner 2. For QIBA DWI QA, they were 0.61±0.63% and 2.59±0.39%, respectively. The measured ADC with ACR DWI QA was highly reproducible and the deviation was consistent with QIBA DWI QA.

CONCLUSION

A new DWI QA method based on the ACR phantom was shown to be reproducible and able to detect similar ADC deviation as the QIBA DWI QA method. The new method is simpler and more feasible for the clinical environment although it is limited to one ADC value and correction for phantom temperature could be an additional source of error.

CLINICAL RELEVANCE/APPLICATION

Development of a DWI QA procedure using the ACR phantom would allow any ACR accredited institution to implement a DWI QA as a part of the weekly QA without additional phantoms or preparation.

SSA22-03 Modulation Transfer Function of Clinical Brain 3D-FLAIR Sequence

Sunday, Nov. 26 11:05AM - 11:15AM Room: S405AB

Participants
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PURPOSE

Typically, image quality in magnetic resonance imaging is evaluated either quantitatively from quality control (QC) phantom images or subjective observer based evaluation of clinical images. However, the phantom-based quality measurements may not fully represent the quality of actual clinical images. An important image quality metrics among image noise and contrast is spatial resolution. In medical imaging, spatial resolution is often characterized by the modulation transfer function (MTF) at a known boundary. It describes the image contrast content at different spatial frequencies. We have developed a method to characterize image resolution by measuring MTF directly from clinical brain volumes obtained with 3D-FLAIR sequence.

METHOD AND MATERIALS

Edge profiles are extracted from a brain surface and direction-dependent MTFs are calculated. First, the original 3D-FLAIR volume is segmented using Statistical Parameter Mapping (Wellcome Trust Centre for Neuroimaging, University College London, UK). The brain mask is further trimmed with an in-house MATLAB (The Mathworks Inc., Natick, MA, USA) application. A mesh grid is fitted onto the mask volume using MATLAB-based open source toolbox iso2mesh. A typical brain surface grid includes from 150 000 to 250 000 triangular polygons. Voxel gray values and distances from the grid are then recorded within cylindrical volumes perpendicular to each polygon face and intersecting the polygon center. Each resulting edge spread function (ESF) is filtered according to predetermined acceptance criteria and the accepted ESFs are centered on the detected edge. Resulting ESFs are averaged, differentiated and Fourier transformed to obtain direction-dependent MTFs.

RESULTS

The developed method was able to determine brain surface direction-dependent MTFs from clinical 3D-FLAIR volumes. Resolution trend curves were calculated over a period of nine months.

CONCLUSION

The developed method provides a quantitative tool for measuring MTF directly from clinical 3D brain images. The MTF can be used to the compare spatial resolution in image volumes obtained with different sequence parameters and scanners. The method can be also applied on-line to follow daily image quality to detect technical or patient related issues.

CLINICAL RELEVANCE/APPLICATION

The calculation of clinical MRI volume MTF provides a quantitative tool for protocol optimization or evaluating and comparing scanners or sequences.

SSA22-04 Characteristics of MRI Patents Approved by the US Patent and Trademark Office in 2016

Sunday, Nov. 26 11:15AM - 11:25AM Room: S405AB

Participants
Sushma Gaddam, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

To use data regarding MRI patents approved by the U.S. Patent and Trademark Office (USPTO) in 2016 to characterize recent trends in MRI technical development and innovation.

METHOD AND MATERIALS

The USPTO website was searched for all patents with an issue date in 2016 and a patent abstract containing the phrase "magnetic resonance". Patent characteristics available on the website were recorded. Patent assignees were manually characterized as having an industry or academic affiliation. An MRI physicist reviewed the abstracts to classify patents' themes. Observations were summarized using standard descriptive statistics.

RESULTS

A total of 423 MRI-related patents were approved by the USPTO in 2016. Of these, a total of 29% had 1 inventor, 24% had 2 inventors, and 47% had >=2 inventors (maximum of 10 inventors). The mean interval between patents being filed and awarded was 1389 ± 559 days (range, 559 to 1,327 days). The most common countries of patents' first assignee were: USA (40%), Germany (24%), Netherlands (10%), Japan (10%), and Korea (4%). There were 14 additional countries (each <2%). A total of 3% of patents included multiple assignees having different countries (most common collaborators being USA and Germany). Patents' 1st assignee had an industry affiliation in 76% vs. an academic affiliation in 21% (4% were indeterminate). A total of 3% of patents had industry-academia collaboration. Patents' most common themes were: coils (n=77), sequence design (n=65), and non-coil scanner hardware (n=41). These top themes were similar for USA, international, and industry based patents; however, for academic based patents, the most common themes were: sequence design, reconstruction, and exogenous agents. Less common themes included: image analysis, post-processing, spectroscopy, relaxometry, diffusion, motion correction, radiation therapy, implants, wireless devices, and PET/MRI.

CONCLUSION

The majority of MRI-related patents approved by the USPTO in 2016 were filed by non-U.S. inventors. A large majority had an industry affiliation; minimal industry-academic collaboration was observed. Patents from industry and academic inventors had distinct top focuses: hardware and software, respectively.

CLINICAL RELEVANCE/APPLICATION

Awareness of the most recent years' MRI patents may provide insights into forthcoming clinical translations and help guide ongoing research and entrepreneurism.

SSA22-05 SI-traceable Imaging Phantoms for MRI

Sunday, Nov. 26 11:25AM - 11:35AM Room: S405AB

Participants
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PURPOSE

To develop primary calibration structures for MRI that have precisely defined properties traceable to the International System of Units (SI). Properties include T1 and T2 proton-spin relaxation times, apparent water diffusion coefficients (ADC), resolution, and geometric distortion. In addition to the primary measurands, the properties of the phantom structure, including dielectric constant, conductivity, and magnetic susceptibility must be determined to fully understand and model MRI-based measurements.

METHOD AND MATERIALS

A suite of MRI phantoms have been designed, fabricated, and commercialized including a system phantom, a diffusion phantom and a breast phantom. These phantoms include paramagnetic solutions for T1 T2 arrays, polymer solutions for ADC calibration, fiducial spheres for geometric distortion, and fat/tissue mimics. The properties of phantom materials are determined through temperature-controlled variable-field NMR, imaging on a MRI metrology scanner, electromagnetic properties measurements, and SQUID magnetometry.

RESULTS

Rigorous but pragmatic definitions of parameters for the major MRI biomarkers have been developed. SI traceable measurement protocols for T1, T2 and ADC and initial measurements have been completed. SI-traceable measurements, with the associated certificates, are expected within 12 months. The phantoms are currently being used at clinical research sites to evaluate new faster quantitative imaging techniques, to homogenize images across scanners, and to develop quality control recommendations for clinical trials evaluating diffusion-based imaging for cancer detection/monitoring. These initial uses have indicated that it is necessary to guarantee phantom-parameter accuracy and stability of 2%.

CONCLUSION

As medical imaging improves with increased reliance on qualitative measurement of critical biomarkers, there is an increasing need for more rigorous calibration structures with the associated SI-traceable measurement of their properties. We have developed a suite of phantoms and associated measurement structure to supply this need.

CLINICAL RELEVANCE/APPLICATION

These phantoms have been used to validate new, faster quantitative imaging techniques such as MR fingerprinting, homogenize scan protocols across different scanner types, assess the change in performance of scanners due to upgrades, assess advanced diffusion imaging protocols in cancer studies and traumatic brain injury diagnosis.

SSA22-06 Display Color in the Interpretation of Apparent Diffusion Coefficient Maps for Prostate Cancer

Sunday, Nov. 26 11:35AM - 11:45AM Room: S405AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Color visualization is prevalent in functional and molecular imaging, the source of most reported imaging biomarkers. Color display selection varies across imaging departments because no guidelines are available and no study has evaluated reader consistency using visualization approaches. In prostate patients, water movement restriction areas in apparent diffusion coefficient (ADC) maps correlate with significant cancer. Inconsistency in quantification and localization reported could result in suboptimal patient management. We report radiologist consistency in detection of prostate lesions to determine the effect of color visualization approaches on diagnostic performance.

METHOD AND MATERIALS

Nine trained readers interpreted 165 single-slice cases, each reading sets of 55 images in 3 separate sessions using a different color scale: gray (G), hot-iron (H), and the inverted rainbow scale (iR). The standard RGB display mode was used for H and iR sessions and the GSDF mode was selected for G. Five readers repeated sessions with iR and H in GSDF mode. Readers used a 0-100 scale to rate their confidence in the presence of a malignant tumor. For cases scored above 50, readers were asked to mark the lowest ADC value within the detected lesion. Pixel values and coordinates were recorded.

RESULTS

The area under the receiver-operating-characteristic curve (AUC) was compared across color scales. Obtained AUCs were 0.79, 0.77 and 0.80 (SE = 0.03) for G, H and iR, respectively, demonstrating a small improvement in detection performance when using iR. A tendency for higher detection sensitivity was observed for RGB setting compared to GSDF for H and iR. Inconsistencies on lesion quantification and localization were non-significant across scales. These results significantly differ from those in a similar study for ischemic lesion detection in myocardial perfusion CT where performance was up to 0.1 AUC units higher using G.

CONCLUSION

Differences in quantification and localization consistency were non-significant. Further investigation is necessary to determine if color affects other diagnostic tasks.

CLINICAL RELEVANCE/APPLICATION

Our findings suggest a small non-significant impact of color for prostate lesion detection in ADC maps, disagreeing with a significant color effect observed in a similar study performed on a different modality.

SSA22-07 Quantitative Estimation of CSF Flow Using MRI Phase Contrast Technique to Assess the Postoperative Outcome of Chiari 1 Malformation with Syringohydromyelia

Sunday, Nov. 26 11:45AM - 11:55AM Room: S405AB

Participants
Rajesh Kumar Vartharajaperumal, MBBS, DMRD, Coimbatore, India (*Presenter*) Nothing to Disclose

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PURPOSE

To quantify the postoperative outcome of chiari 1 malformation using CSF flow study. To evaluate the efficacy of surgery and to assess the prognosis in the early postoperative period.

METHOD AND MATERIALS

Fifty patients with chiari 1 malformation with syringohydromyelia who are ideal candidate for surgery were subjected to MRI brain and spine and CSF flow analysis using MR phase-contrast technique. Region of interest was kept at the level of aqueduct and assessed the positive peak velocity , negative peak velocity and flow . All patients underwent posterior fossa decompression

surgery. Post operative velocity and flow measurements of all patients were taken. We compared the pre and post operative flow volume and velocity.

RESULTS

Of the 50 patients, 36 patients showed significant change in the velocity and flow in the early postoperative period and had resolution of clinical signs and symptoms during follow up. 10 patients showed mild changes in flow and velocity in the early postoperative period with partial recovery of symptoms during follow up and in 4 patients , there is minimal change in velocity and flow during early postoperative period with persistence of symptoms during follow up.

CONCLUSION

Patients with significant changes in flow and velocity in the early postoperative period will have better clinical recovery when compared to patients with minimal change.

CLINICAL RELEVANCE/APPLICATION

Improved CSF velocity and flow in the early postoperative period is useful in anticipation of symptomatic improvement and useful in assessing the efficacy of surgery and long term prognosis.

SSA22-08 Non-ECG-gated and Non-enhanced MR Venography in Arrhythmia

Sunday, Nov. 26 11:55AM - 12:05PM Room: S405AB

Participants
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Jun Kaneko, Hasuda, Japan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To selectively visualize lower extremity varicose veins in arrhythmia patients without contrast media by the use of a free-ECG-gating Flow-Sensitive Black Blood (FSBB) technique.

METHOD AND MATERIALS

A FSBB technique doesn't need an ECG-gating and allows b values to be adjusted in increments of 0.1 value as one-tenth of usual 1 value. A protocol optimization was performed on 20 healthy volunteers while they changed their lower limb position up and down in the supine or seated position. Subsequently, the revised FSBB protocol parameters were applied to 25 arrhythmia patients of varicose veins with difficulty in diagnosis on usual ECG-gated MRA techniques. All the studies were performed on a 1.5T MRI system (EXCELART Vantage XGV Toshiba) equipped with a SPEEDER torso coil. FSBB imaging was performed as follows; T2*-weighted 3D gradient echo sequence, b value; 0.1-0.4, and typical scan time; 5 min. The performance of FSBB on the lower extremity venous systems was assessed for the image contrast as compared with the other unenhanced ECG-gated MRA techniques.

RESULTS

The scan time of FSBB was almost equal to that of time-of-flight (TOF) and half-Fourier FSE MRA (FBI) using usual ECG-gating techniques. Unenhanced MRA showed excellent depiction of complex venous plexus and age-related vasodilatation while changing their lower limb positions, especially in their legs lowered on seated position. FSBB provided an excellent anatomical depiction of tortuous varicose veins in arrhythmia patients as a dynamic imaging.

CONCLUSION

FSBB technique is independent of ECG-gating and allows exam integrity even in arrhythmia patients and can consequently shorten exam time, so it may provide a valuable procedure for diagnosis of peripheral vascular imaging. Selective visualization of varicose sources in arrhythmia patients without contrast media is of increasing significance for an interventional procedure in our aging population.

CLINICAL RELEVANCE/APPLICATION

Visualization of the lower limb venous systems of arrhythmia patients without contrast material is quite difficult using conventional unenhanced MR angiography. FSBB imaging is a new clinical tool with the use of MR susceptibility difference between tissue and vessels. It has been proven to be useful for brain imaging. In this study, we extended the application of FSBB to the lower extremity veins to investigate if FSBB could provide an additional benefit beyond the brain.

SSA22-09 Advanced Fat Suppression Techniques for Off-Center Upper Extremity MSK MRI on 3T Scanners

Sunday, Nov. 26 12:05PM - 12:15PM Room: S405AB

Participants
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CONCLUSION

Field sensitive sequences like Spectral FS techniques can have fat suppression inhomogeneities, signal loss and blurring due to gradient pulsing and higher order eddy currents with off-center scans on 3T. Depending on patient position, the FS sequence parameters may need to be adjusted to minimize these effects.

Background

3T MR scanners provide high quality MR images, better SNR and resolution in shorter scan times. However, fat suppression on 3T is challenging for wrist and elbow MSK scans; specifically, off-center scans with small FOV. We observed inhomogeneous fat suppression, non-patient-motion related ghosting/ blurring and poor SNR on 3T for off-center scans using traditional spectral fat suppression (FS). The same protocols on iso-center scans produced excellent image quality.

Evaluation

Multiple phantom and wrist scans were performed on volunteers to determine the source for poor image quality. Mapping of the B1 (RF) field, static B0 field and the dynamic B0 field with the body coil and wrist coil were performed. Qualitative and quantitative comparisons were made with the spectral FS sequence with changes in gradient pulsing. Scan parameters were changed to maximize SNR with complete and uniform fat suppression while maintaining small FOV and high resolution requirements.

Discussion

Analysis showed that the primary source of inhomogeneous FS and lower SNR for off-center scans on 3T was higher order eddy currents (dynamic B0 field) due to gradient pulsing. No static B0 or B1 (RF) field inhomogeneities were found to be contributing to the issues. Changing the gradient pulsing changed the FS results, further confirming that errors observed were dynamic in nature. Swapping the phase or reversing the polarity of the phase encoding direction for right vs. left MSK scans, depending on the patient position (head or feet first, right or left, supine or prone) helped improve the image quality for off-center scans in terms of SNR and signal uniformity. STIR and SPAIR sequences were not evaluated due to image contrast differences from traditional sequences. But DIXON water images were chosen to be a backup if traditional off-center FS with eddy-current compensation failed.

SSA23

Radiation Oncology (Radiobiology)

Sunday, Nov. 26 10:45AM - 12:15PM Room: S104A

OI PH RO

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSA23-01 DNA Damage in Lymphocytes after Low Dose Chest CT

Sunday, Nov. 26 10:45AM - 10:55AM Room: S104A

Participants
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PURPOSE

CT is now the largest source of radiation exposure in diagnostic imaging and the risk of cancer from CT is a rising concern in the medical community. Therefore, various imaging techniques including iterative reconstruction algorithms have been developed to reduce radiation dose. With these techniques, chest CT can be scanned with low dose (effective radiation dose: 1-3mSv). Although earlier studies reported that DNA damage was induced by CT, it is yet unknown at what dose DNA damage is likely to occur. The purpose of this study was to determine whether DNA damage can occur with low-dose chest CT.

METHOD AND MATERIALS

We obtained institutional review board approval and the written informed consent from 74 patients (32 men, 42 women, median age 69 years, range 28-87 years) who underwent low dose chest CT. All low dose chest CT were scanned on a 320-detector CT scanner (Aquilion One; Toshiba Medical Systems, Otawara, Japan) in helical scan mode. The scan parameters were 120 kVp, 100mA, rotation time 0.5 sec, detector configuration 80 x 0.5mm. Blood samples were obtained before- and 15 minutes after CT. We identified DNA damages (DNA double-strand breaks) in lymphocytes as cytologically visible "foci" by using an antibody against γ-H2AX. The statistical difference was determined by two-sided paired t test. Difference with $P < 0.05$ was considered significant.

RESULTS

The mean γ-H2AX foci number before CT and 15 minutes after CT were 3.3 (SD: 2.2) and 3.3 (2.4) foci/cell, respectively. The γ-H2AX foci number was not significantly increased after CT. The mean effective dose of low dose chest CT was 1.9 (0.2) mSv.

CONCLUSION

Low-dose chest CT failed to induce DNA double strand breaks in lymphocytes.

CLINICAL RELEVANCE/APPLICATION

Our results may prove biological validity for CT lung cancer screening from the standpoint of radiation exposure.

SSA23-02 Nanoparticle Imaging and Treatment of Primary and Metastatic Tumor, Through Macrophage Therapy and the Abscopal Effect, Respectively, by Radiotherapy-Directed Targeted Switching of TAMs from an M2 to M1 Phenotype and Activation of Primed CD8+ T Ce

Sunday, Nov. 26 10:55AM - 11:05AM Room: S104A

Participants
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PURPOSE

We aimed to image and treat primary tumors and metastasized tumors *in vivo*, through macrophage-based therapy and abscopal

We aimed to image and treat primary tumors and metastasized tumors in vivo, through macrophage-based therapy and abscopal effect, respectively, in LM17 cell xenografts in BALB/c mice using microcapsules that released liposome-protamine-hyaluronic acid nanoparticles (LPH-NPs) in response to three sessions of radiation.

METHOD AND MATERIALS

For session one, LPH-NPs containing 5% iopamiron, and 250 nmol anti-CD47 siRNA were mixed with 1.0 mL oxygen-rich solution (2200 ppm O2) containing 4.0% alginate, 3.0% hyaluronate, and 1 μg/mL P-selectin antigen (Ag) solution and added to 0.5 mM FeCl2 with 1 μg/mL a4ß1 antibody (Ab). The microcapsules (1 × 1010) were injected intravenously (IV). After 9 h, primary tumors were exposed to 10 or 20 Gy 60Coγ-rays. In session two LPH-NPs containing 200 μg anti-CD40 monoclonal Ab (MAb) and 9.0 X 105 IU IL-2 were mixed with the above cocktail and added to 0.5 mM FeCl2 with 1 μg/mL anti-P-selectin Ab. Microcapsules (1 × 1010) were injected IV and they interacted with P-selectin. After 9 h, the second radiation session was conducted using the same protocol as for the first session. In session three, 4 cGy 60Co whole-body γ-rays were administered at 24-h intervals for 5 days.

RESULTS

Following session one, anti-a4ß1 microcapsules accumulated around the primary tumors and metastases, which were detected by CT. The microcapsules released P-selectin Ag, anti-CD 47 siRNA LPH-NPs and O2-rich water, which silenced "don't eat me" signals and increased [O2] in tumors. In session two, the microcapsules accumulated around the primary tumor through a P-selectin Ag-Ab reaction. By second radiation, released LPH-NPs containing anti-CD 40 MAb /IL-2 switched the phenotype of Tumor Associated Macrophages (TAMs) from M2 to M1, and repeatedly released an O2-rich water inhibited TAMs from repolarizing back to M2 phenotype, which intensified tumor phagocytosis by M1 macrophages. Additionally, anti-CD 40 MAb enhanced cross priming of CD8+ T-cells to tumor. In session three, primed CD8+ T-cells were activated and attacked metastases. These treatments reduced the size of primary tumors and metastases by 87 ± 4.6%.

CONCLUSION

Our targeted macrophage therapy has the potential to improve tumor diagnosis and treatment.

CLINICAL RELEVANCE/APPLICATION

Nanoparticles improved tumor imaging. Targeted switching of macrophage phenotype from M1 to M2 and cross priming of CD8+ T-cells enhanced the effects of radiotherapy on primary tumors and metastases.

SSA23-03 Inhibitors of HIF-1a and CXCR4 Mitigate the Development of Radiation Necrosis in Mouse Brain

Sunday, Nov. 26 11:05AM - 11:15AM Room: S104A

Participants
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PURPOSE

There is mounting evidence to indicate that, in addition to angiogenesis, hypoxia-induced inflammation via the hypoxia inducible factor-1a (HIF-1a) / CXC chemokine receptor-4 (CXCR4) pathway, may also contribute to the pathogenesis of late-onset, radiation-induced necrosis (RN). In the present study, we investigated the mitigative efficacy of an HIF-1a inhibitor, topotecan, and a CXCR4 antagonist, AMD3100, on the development of RN in an intracranial mouse model.

METHOD AND MATERIALS

Mice received a single-fraction, 50-Gy dose of hemispheric radiation using the Leksell GammaKnife and were then treated with either topotecan, from 1-12 weeks post-irradiation (PIR), or AMD3100, from 4-12 weeks PIR. The onset and progression of RN were monitored longitudinally via noninvasive, in vivo MRI from 4 to 12 weeks PIR. Conventional hematoxylin and eosin (H&E) staining and immunohistochemistry (IHC) staining were used to further evaluate the treatment response.

RESULTS

The progression of brain RN was significantly mitigated in mice treated with either topotecan or AMD3100, compared to control animals. MR-derived lesion volumes were significantly smaller for both of the treated groups, and histologic findings correlated well with the MRI data. By H&E staining, both treated groups demonstrated reduced radiation-induced tissue damage compared with controls. Further, the IHC results revealed that expression levels of VEGF, CXCR4, CXCL12, Iba-1, CD-68, CD3 and TNF-a in the lesion area were lower in treated brains vs. control brains. HIF-1a expression persisted in topotecan-treated animals, but was reduced markedly by treatment with AMD3100. IL-6 expression was unaffected by either topotecan or AMD3100.

CONCLUSION

By mitigating inflammation, both topotecan and AMD3100 can, independently, mitigate the development of RN in mouse brain. When combined with first-line, anti-angiogenic treatment, anti-inflammation therapy may provide an adjuvant therapeutic strategy for clinical, post-radiation management of tumors, with additional benefits in the mitigation of RN development.

CLINICAL RELEVANCE/APPLICATION

(Dealing with radiation necrosis and inflammation)Treatment with topotecan or AMD3100 can significantly inhibit the HIF-1a/CXCR4 axis, thereby reducing the progression of RN. Targeting the HIF-1a/CXCR4 pathway may be a promising therapy in treating

recurrent tumor post-RT, with additional benefit for mitigating the progression of RN'.

SSA23-04 Radiation Inhibits Lymphangiogenesis in Acquired Lymphedema Hindlimb Mouse Models

Sunday, Nov. 26 11:15AM - 11:25AM Room: S104A

Participants
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PURPOSE

This study was aimed to evaluate the effect of radiation on acquired lymphedema in hindlimb mouse model.

METHOD AND MATERIALS

Total 20 BALB/c female mice of 8-week-old were equally assigned to two groups. In both groups, popliteal lymph node and surrounding fat pad were resected. In radiation group, all mice received 20 Gy radiation exposure 1 day after surgery. The methods of evaluation include measuring the thickness of ankle, fluorescence lymphography at the end of 1, 2, 3, 4 week.

RESULTS

The mean thickness values of ankle in radiation group at 1,2,3,4 weeks were 4.64 mm, 4.26 mm, 3.98 mm, 3.80 mm, respectively. The mean thickness values of ankle in non-radiation group at 1,2,3,4 weeks were 4.29 mm,4.10 mm,4.27 mm, 4.02 mm, respectively. Difference was statistically significant in 1 week and 2 weeks ($P<0.05$). Collateral lymph vessels draining to the inguinal LN were detected in 10% of mice in radiation group, but 100% of mice in non-radiation group at 4 week fluorescence lymphography.

CONCLUSION

Radiation inhibits the lymphangiogenesis after popliteal lymph node resection, which indicates that it is an essential factor for developing acquired lymphedema in mouse hindlimb model.

CLINICAL RELEVANCE/APPLICATION

Secondary lymphedema in humans is a common consequence of axillary lymph node dissection (ALND) to treat breast cancer. To further investigation of the mechanism and treatment of lymphedema,a stable and reproducible animal model is needed. In our present study, radiation is an essential factor for developing acquired hindlimb lymphedema mouse model, which is helpful to develop a new hindlimb lymphedema mouse model.

SSA23-05 Localized Mild Hyperthermia for Radiosensitization in an Orthotopic Prostate Tumor Model in Mice

Sunday, Nov. 26 11:25AM - 11:35AM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): The use of mild hyperthermia (41-43° C) as a modality for treatment of cancer is gaining interest. Studies have shown hyperthermia causes chemoradiosensitization and can be used to enhance the therapeutic effects of immunotherapy. Numerous in vivo studies have demonstrated hyperthermia-induced radiosensitization in subcutaneous tumor models; however, to our knowledge there are no studies that demonstrate the ability to deliver targeted hyperthermia from an external source to a deep-seated orthotopic tumor in the abdominal/pelvic region. Subcutaneous models lack the degree of translatability possessed by orthotopic models, as they don't represent the tumor microenvironments of the original tumor to the extent in which orthotopic tumors do. The objective of this preclinical study was to demonstrate the use of radiofrequency (RF) to induce mild hyperthermia in deep-seated tumors. In order to illustrate proof-of-concept, we developed and utilized an orthotopic intra-prostatatic tumor model in nude mice.Materials/Methods: The ventral lobes of the prostate of nude mice were injected with 1 x 105 PC3 cells transfected with luciferase through an open abdominal incision. Inoculation was confirmed with bioluminescence (BLI) imaging on day 3. BLI and ultrasound were used to track tumor growth and tumor volumes were calculated. RF-induced hyperthermia was delivered using the Oncotherm LAB EHY-100 device. The target temperature was 41° C as measured by a thermal probe placed in the rectum. RF was delivered through an electrode centered over the prostate and coupled to the skin via a thin layer of ultrasound gel in order to minimize dielectric inhomogeneities which can lead to eddy currents and thereby skin burns. The RF power was gradually increased from 0.3 watts until the desired temperature of 41° C was achieved. The treatment time per animal was 30 minutes.Results: Successful tumor inoculation was performed in all four mice as detected with bioluminescence. Average signal at confirmation was 4.25 x 107 photons/sec within the region of interest (ROI). Tumors were first detected by ultrasound on days 9-15. Average tumor

diameter at earliest detection was 4.8 mm (3.9-5.3 mm). Average tumor doubling time was 5 days. Hyperthermia was safely administered to the mice without toxicities. Fifteen to 45 minutes were needed to achieve the target temperature of 41° C.Conclusion: We were successful in establishing an orthotopic prostate tumor model in nude mice. Ultrasound and BLI both served as a reliable and efficient imaging modality to track tumor growth. To our knowledge, this is the first demonstration that radiofrequency can be used to safely and reproducibly deliver mild hyperthermia to a deep-seated tumor in the abdominal/pelvic region in a mouse model.

SSA23-07 Radiotherapy Induces Cell Arrest and Cell Apoptosis in Nasopharyngeal Carcinoma via the ATM and Smads Pathways

Sunday, Nov. 26 11:45AM - 11:55AM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): Nasopharyngeal carcinoma (NPC) is a common malignant neoplasm worldwide and harmful to human's health. Radiotherapy is commonly used in treating NPC and it induces immediate cell cycle arrest and cell apoptosis. However, the mechanism behind is recently maintained unknown. Evidences suggested the activation of Ataxia telangiectasia mutated (ATM) pathway and Smads pathway is the crucial mediator in the functions of radiotherapy.Materials/Methods: In this study, we carried out in vitro assays with CNE-2 cells and in vivo assays with nude mice in purpose of investigating the relationship between NPC and the ATM and Smads pathways. Results: The results suggested that radiation induced activation of ATM pathway that the expression of p-ATM, p-CHK1, p-CHK2 and p15 was increased; but it induced inhibition of the Smad3/7 cascade that the increased level of Smad7 suppressed the expression of p-Smad3. As a result, the cleaved Caspase3 was up-regulated expressed and CDC25A was down-regulated expressed and thereby cell cycle arrest and cell apoptosis occurred. On the other hand, the results also suggested the interaction between the ATM and Smads pathways. Activation of Smad3 can induce inhibition to ATM pathway and thereby the efficacy of radiation will be attenuated.Conclusion: In summary, we suggest that both ATM and Smad pathways contribute to the cell cycle arrest and cell apoptosis during radiation.

SSA23-08 Quantification of Cell-Free DNA in Breast Cancer Patients Receiving Adjuvant Radiotherapy

Sunday, Nov. 26 11:55AM - 12:05PM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): Cell-free DNA (cfDNA) is released by healthy and malignant tissues into peripheral blood upon cell death. The concentration of cfDNA has been shown to vary in cancer patients, but the effects of radiotherapy (RT) are not known. The objective of this study was to serially evaluate cfDNA concentration from women receiving adjuvant RT for breast cancer. We hypothesized that cfDNA is released by damaged cells into the bloodstream resulting in an increase in total cfDNA concentration during adjuvant RT. Materials/Methods: Women receiving post-operative RT for breast cancer were enrolled in a prospective biomarker study in which phlebotomy was performed at 5 serial time points: baseline; 1 day following initiation of RT; 5 days following initiation of RT; at completion of RT; and 1 month following the completion of RT. We identified 4 patients treated with lumpectomy undergoing adjuvant RT who had provided all 5 blood samples. cfDNA was extracted from 1-2mL of peripheral blood plasma using the QIAamp Circulating Nucleic Acid Kit (Qiagen). The concentrations of double-stranded and single-stranded cfDNA at each time point were measured using Qubit kits (Life Technologies). Results: The 4 patients selected for analysis were diagnosed with ductal carcinoma in situ (N=3) or T1aN0M0 invasive lobular carcinoma (N=1). Mean age was 64 years (range: 56-75). Adjuvant RT consisted of intensity-modulated RT to a dose of 42.4Gy in 16 fractions, either to the right (N=2) or left (N=2) breast. None of the patients received chemotherapy or hormonal therapy. The lung volume receiving 20Gy or more (V20Gy) was 103-110cc for right- and 50-65cc for left-sided disease. 10cc of the heart received at least (D10cc) 0.7-0.8Gy for right- and 6.5-7.9Gy for left-sided disease. Double-stranded cfDNA concentration ranged from 1.7 – 13.3 ng per mL plasma (mean±SD 6.6±2.9). Single-stranded cfDNA concentration ranged from 8.6 – 54.4 ng per mL plasma (mean±SD 27.4±13.8). The concentrations of double-stranded and single-stranded cfDNA did not correlate with lung or heart dose and did not change significantly throughout the RT course ($p>0.05$ for all). Conclusion: The majority of plasma cfDNA exists as single-stranded DNA in patients undergoing adjuvant RT for breast cancer. The concentrations of double-stranded and single-stranded cfDNA did not change significantly throughout the RT course and did not correlate with doses to organs-at-risk.

SSA24

Vascular Interventional (IO-Lung Cancer)

Sunday, Nov. 26 10:45AM - 12:15PM Room: E350

CH CT IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSA24-01 Towards Transpulmonary Chemoembolization with Degradable Starch Microspheres: Systematic Analysis of Local and Systemic Effects in a Porcine Model

Sunday, Nov. 26 10:45AM - 10:55AM Room: E350

Participants
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PURPOSE

To systematically investigate local and systemic effects of transpulmonary chemoembolization (TPCE) with degradable-starch-microspheres (DSM) and doxorubicin. Long-term goal is to establish DSM-TPCE as treatment option for pulmonary malignancies.

METHOD AND MATERIALS

9 pigs underwent TPCE via a catheter placed in either the right or left lower-lobe-pulmonary-artery (LLPA) and bland embolization (TPE) of the contralateral LLPA . Pulmonary-arterial pressure, heart-rate and oxygenation were recorded immediately before and at 1, 3, 5 and 10 minutes after treatment. To investigate possible non-target embolization, animals underwent cerebral MRI. Animals were sacrificed after a contrast-enhanced chest CT for pathologic examination 12 hours (3), 24 hours (3) and 72 hours (3) after treatment.

RESULTS

Mean injected DSM-dose until stasis was similar in TPCE and TPE (4.2±1.4 vs. 4.5±1.5mL). Pulmonary-arterial pressure increased significantly 3 minutes after treatment (TPE: 17±5 vs. 27±7mmHg; TPCE: 22±6 vs. 36±8mmHg). No systemic cardiovascular effects, i.e. no change of heart-rate or oxygenation pre- vs. post TPCE or TPE were observed. No evidence of structural lung damage or permanent perfusion obstruction was observed on contrast-enhanced CT. No non-target embolization was found on cerebral MRI. Pathologic assessment revealed nonspecific local inflammation of the lung parenchyma, with increasing degree from 12 to 72h after treatment.

CONCLUSION

In this large-animal modal, TPCE and TPE appear feasible and safe. Only a clinical asymptomatic, mild increase in pulmonary-arterial pressure was observed. Non-target embolization to the brain did not occur. TPCE, as well as TPE did not cause significant damage to the normal lung-parenchyma.

CLINICAL RELEVANCE/APPLICATION

Transpulmonary chemoembolization is a treatment option for non-resectable pulmonary malignancies. It is minimally invasive and allows delivery of high chemotherapy doses to the tumor. The results of this preclinical study justify the conductance of TPCE for treatment in patients with malignant lung tumors to deliver higher doses of the chemotherapeutic agent to the tumor and meanwhile reduce side effects.

SSA24-02 To Evaluate the Clinical Utility of an Electromagnetic Navigation System for Performing Liver Biopsies with Real Time PET-CT and US Fusion

Sunday, Nov. 26 10:55AM - 11:05AM Room: E350

Participants

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PURPOSE

To evaluate the clinical utility of an electromagnetic navigation system for performing liver biopsies with real time PET-CT and US fusion.

METHOD AND MATERIALS

Fusion of PET-CT and US was performed during biopsies for 32 patients with liver metastasis. Twenty-four showed heterogeneous lesions (mixed SUV values with probably necrotic areas) and 8 showed homogenous lesions (smooth and homogeneous distribution of SUV values). Clinical impact of fusion was evaluated according to the following criteria: i) re-planification of target after fusion ii) localization- visualization of the lesion. iii) Success of the biopsy.

RESULTS

For the group of heterogeneous lesions, fusion has changed the target of the radiologist in all 24 cases aiming intra-tumoral regions of high FDG uptake. For the homogeneous lesions group, in 6 cases the fusion helped to better visualize the lesion either because of low US contrast (2 cases) either because of localization in the liver dome (4 cases). All biopsies were successful with sufficient material for sequencing.

CONCLUSION

Real time fusion of PET-CT and US has facilitated the biopsy for all 23 heterogeneous lesions and for 6 out of 8 homogeneous lesions.

CLINICAL RELEVANCE/APPLICATION

Using functional information during liver biopsies can facilitate the interventional radiologist by targeting only the FDG active therefore highly cellularised regions of the tumor. Moreover it increases radiologists' confidence with better visualization and localization of the lesion especially in difficult liver regions such as the dome. In the future functional imaging will be more involved in the planification of percutaneous biopsies.

SSA24-03 Ablation Therapy of Non-Colorectal Cancer Lung Metastases: Retrospective Analysis of Tumor Response post Laser-Induced Interstitial Thermotherapy (LITT) Radiofrequency Ablation (RFA) and Microwave Ablation (MWA)

Sunday, Nov. 26 11:05AM - 11:15AM Room: E350

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PURPOSE

To retrospectively compare the local tumor response and survival rates in patients with non-colorectal cancer lung metastases post ablation therapy using laser-induced thermotherapy-(LITT), radiofrequency ablation-(RFA) and microwave ablation-(MWA).

METHOD AND MATERIALS

Retrospective analysis of 175 CT-guided ablation sessions performed on 109 patients (43 males and 66 females, mean age: 56.6years). 17 patients with 22 lesions underwent LITT treatment (tumor size: 1.2-4.8cm), 29 patients with 49 lesions underwent RFA (tumor size: 0.8-4.5 cm) and 63 patients with 104 lesions underwent MWA treatment (tumor size: 0.6-5 cm). CT-scans were performed 24-hours post therapy and on follow-up at 3, 6, 12, 18 and 24 months.

RESULTS

The overall-survival rates at 1-,2-,3- and 4-year were 93.8%,56.3%,50.0% and 31.3% for patients treated with LITT,81.5%,50.0%,45.5% and 24.2% for patients treated with RFA and 97.6%, 79.9%,62.3% and 45.4% for patients treated with MWA respectively. The mean survival-time was 34.14 months for MWA, 34.79 months for RFA and 35.32 months for LITT. In paired comparison a significant difference could be detected between MWA versus RFA (p=0.032). The progression-free survival showed a median of 23.49 ± 0.62 months for MWA,19.88 months ±2.17 months for LITT and 16.66 ± 0.66 months for RFA(p=0.048). The lowest recurrence rate was detected in lesions ablated with MWA (7.7%; 8 of 104 lesions) followed by RFA (20.4%; 10 of 49 lesions) and LITT (27.3%;6 of 22 lesions) p- value of 0.012. Pneumothorax was detected in 22.16% of MWA ablations, 22.73% of LITT ablations and 14.23% of RFA ablations.

CONCLUSION

LITT, RFA and MWA may provide an effective therapeutic option for non-colorectal cancer lung metastases with an advantage for MWA regarding local tumor control and progression-free survival rate.

CLINICAL RELEVANCE/APPLICATION

LITT, RFA and MWA have a therapeutic potential regarding local tumor control and progression-free survival rate patients with non-colorectal cancer lung metastases .

SSA24-04 Image Guided Tumor Biopsies in a Prospective Molecular Triage Study (MOSCATO 01): What Are the Risks?

Sunday, Nov. 26 11:15AM - 11:25AM Room: E350

Participants
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PURPOSE

To describe complications of percutaneous image-guided biopsies for genomic analysis in cancer patients, their management and to determine pre-procedural risk factors.

METHOD AND MATERIALS

Data from biopsies performed at a single center in the prospective MOSCATO-01 clinical trial were recorded between November 2011 and March 2016.Data included patient demographics, previous therapies, and biology reports.Tumor and procedure characteristics were evaluated.Complications, their management, and tumor cellularity were recorded.Univariate and multivariate analysis was performed to determine predictive factors for complications.

RESULTS

Seven-hundred and forty biopsies were performed on 689 patients, with a mean of 4 samples per biopsy. Biopsies were performed on tumors in the liver (n:=:297), lung (n:=:184), lymph nodes (n:= 121), bone (n:=:14), or another site (n:=:122) under CT (31%) or US guidance (69%). Seventy patients (10%) experienced a complication including 67% grade 1, 23% grade 2, 10% grade 3, 0% grade 4 and the mortality rate was 0%. Most common complications were pneumothorax (61%), hemorrhage (24%) and pain (7%) and none was life-threatening. Among 10 hemorrhagic complications, 3 required trans-arterial embolization. Tumor location (lung), renal function (creatinine as a continuous variable), lesion size (as a continuous variable), depth (distance to pleura for lung biopsies, as a continuous variable) and prone position, were found as predictive factors for complication in univariate analysis.By multivariate analysis:only tumor location (lung vs other) OR=1.26 [1.18-1.34], and depth for lung biopsies OR=1.26 [1.18-1.34], were significant risk factors in our population.Biopsies where contributive for genomic analysis in 88% of cases.

CONCLUSION

Percutaneous image-guided core-needle biopsies are feasible and safe in cancer patients for molecular screening. The different risk factors identified did not increase mortality or preclude the successful acquisition of useful tissue for genomic analysis.

CLINICAL RELEVANCE/APPLICATION

umor biopsies are key for genomic analysis to drive targeted therapies matching specific molecular alterations. Percutaneous image-guided biopsies are feasible and safe.

SSA24-05 Feasibility Study of CT-Guided Needle Insertion Using Stereotaxic Unit for Lung Biopsy

Sunday, Nov. 26 11:25AM - 11:35AM Room: E350

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PURPOSE

Purpose of this study is to evaluate accuracy and feasibility of CT-guided, robot-assisted needle placement of lung lesion

Purpose of this study is to evaluate accuracy and feasibility of CT-guided, robot-assisted needle placement of lung lesion

METHOD AND MATERIALS

The robot system including 5-axis robot arm, a mobile platform with motor controllers, dedicated workstation for planning of needle path, and the navigation system (Polaris Spectra®; NDI, Canada) was developed. It provides useful functions including such as needle path planning, respiration monitoring, laser guidance, automatic needle positioning and guiding. To evaluate the feasibility and accuracy of the system in needle placement, patient with lung lesions requiring biopsy were included. Under CT guidance. CT scan was performed to localize the target lesion and the CT data was transferred to the system. The spatial relation between patient and the robot system was registered with navigation system. After planning the needle path on workstation, the spatial information was translated to the robotic system. The robot system automatically angulates the needle to the target and depth of insertion is determined. Total of 21 needle insertion trials were performed. Using the CT images after the insertion, distance between the target and actual needle tip and angle between preplanned route and actual needle pathway were measured.

RESULTS

The distances between the target and the needle tip for robot assisted was 8.13±5.2mm. Angular deviation was 4.49±2.86°. Procedure was 17m45s±4m36. Since additional CT scanning was performed. Small amount of pneumothorax occurred in three patients, but no additional procedures were needed. Small amount of hemoptysis occurred in one patient.

CONCLUSION

Developed robot system provides comparable accuracy of CT guided needle placement for lung lesion to conventional procedure.

CLINICAL RELEVANCE/APPLICATION

Compared with conventional biopsy procedures, it is expected to use tools that make it easier to perform biopsy by lowering barriers to entry by non-experts.

SSA24-06 Meteorological Conditions and Incidence of Pneumothorax and Chest Tube Placement after Percutaneous CT-Guided Lung Biopsy

Sunday, Nov. 26 11:35AM - 11:45AM Room: E350

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PURPOSE

Previous studies suggest that changes in atmospheric pressure may correlate with the incidence of idiopathic spontaneous pneumothorax. The aim of our study was to retrospectively evaluate the meteorological variables that may influence rates of pneumothorax and chest tube placement after percutaneous CT-guided lung biopsy, in particular the atmospheric pressure (P) and temperature (T).

METHOD AND MATERIALS

We analyzed 338 percutaneous CT-guided lung biopsies performed with 20-gauge coaxial cutting needles between December 2011 and May 2014. For each day within the period analyzed, the mean P (mP), as well as mean (mT), maximal, and minimal temperatures, were recorde. To evaluate the influences of pressure changes, differences in mP were calculated from one day before and one day after the procedure. We also recorded the humidity and presence or absence of special weather conditions (thunderstorms, snow, and rainfall). Unequal variance t test was used to measure the degree of association. P-value <0.05 was considered significant.

RESULTS

The overall incidence of pneumothorax was 34.0% (115/338), with 26.1% (30/115) requiring chest tube placement (8.9% of all procedures). The average mP and mT were 29.9 ± 0.2 inches of mercury (inHg) and 58.2 ± 17.01°F, respectively, during the study period. The mP did not correlate significantly with post-biopsy pneumothorax (p= .277) or chest tube placement (p=.767). There was also no correlation between the mT and post-biopsy pneumothorax (p=.619) or chest tube placement (p=.987). Pressure changes, humidity, and special weather conditions did not significantly influence the occurrence of pneumothorax or chest tube placement. No threshold in the mP was found to determine the probability of pneumothorax occurrence or chest tube placement rate.

CONCLUSION

Although meteorological factors may impact incidence of spontaneous pneumothorax, no correlation was found in our study between these factors and incidences of post-biopsy pneumothorax and chest tube placement. Further studies could confirm these findings with a larger study population, as well as investigate the impact of more rapid and profound pressure changes, such as in the setting of air travel, on these complications.

CLINICAL RELEVANCE/APPLICATION

Routine weather fluctuations do not impact the incidence of post-biopsy pneumothorax, despite correlations with spontaneous pneumothorax, and should not impact procedure planning.

SSA24-07 Percutaneous Cryoablation of Metastatic Lung Tumors: High Efficacy with Low Morbidity

Sunday, Nov. 26 11:45AM - 11:55AM Room: E350

Participants

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PURPOSE

To assess technical feasibility, efficacy and complication rates of CT guided cryoablation of metastatic lung tumors in multiple locations.

METHOD AND MATERIALS

CT fluoroscopic-guided percutaneous cryoablation was performed in 185 procedures on 252 metastatic lung tumors in 104 patients. Tumor and ablation volumes, location, abutting vessels >3mm, recurrences, and PFT's were reviewed for all patients. Complications were graded by the National Institutes of Health, Common Terminology of Complications and Adverse Events 4.0 (CTCAE).

RESULTS

All procedures were performed with conscious sedation. Mean FEV1 and DLCO2 were 86.6% (32-144%) and 76.9% (29-110%), respectively. Overall tumor and ablation mean size was 2.0 cm (0.5 - 12.3 cm) and 4.1 cm (2.1-12.8), respectively. Total major complication rates were only 3.7% (7/185), and were not statistically significant between tumors <=3 cm (2.8% N=4/147) vs >3cm (7.9% N=3/38) (p>0.1). No statistical significance was noted for major complications with central tumors or major vessel proximity (p>0.1). A pneumothorax occurred in 88 procedures (47.6%) of which 43 (23.2%) were self-limited resolving without intervention and 42 (22.7%) requiring immediate suction or short term chest tube (< 24hrs). Only 3 (1.6%) procedures required prolonged chest tube (>grade 3). Recurrence rates of 5.2% (13/252) were greater in tumors >3cm (12.2% N=5/41) vs tumors <3cm (3.8% N=8/211) (p<0.05). Although recurrence rates increased for central tumors near major vessels 7.0% (7/100) compared with peripheral tumors 3.9% (6/152) this was not statistically significant (p> 0.1).

CONCLUSION

CT guided percutaneous cryoablation of lung metastasis provides a low morbidity alternative with one of the highest efficacy rates noted in literature, regardless of tumor size. Tumor size and location does not significantly affect complication rates.

CLINICAL RELEVANCE/APPLICATION

Appropriately delivered thoracic metastasis cryoablation is affected by tumor size yet still produces very low recurrence and complication rates.

SSA24-08 Lung Metastases: Role of Transpulmonary Chemoembolization (TPCE) in a Palliative or Neoadjuvant Intention

Sunday, Nov. 26 11:55AM - 12:05PM Room: E350

Participants
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PURPOSE

To evaluate tumor response, local tumor control and survival after the treatment of secondary lung metastases using transpulmonary chemoembolization (TPCE) in palliative and neoadjuvant intention.

METHOD AND MATERIALS

Between 08/04 and 11/16 142 patients (mean 56.6±13.5 years; 73 females, 69 males) with unresectable lung metastases underwent repetitive TPCE (mean: 5.7±2.8 sessions). Primary tumors were colorectal carcinoma (n=58), breast cancer (n=27), sarcoma (n=13), renal cell carcinoma (n=8) and others (n=36). Bilateral lung involvement occurred in 79.6% of patients (median number of lung nodules: 10). 50 patients who underwent subsequent ablation either for all lesions (complete) or some lesions (incomplete) were included. Preinterventional MRI and postinterventional CT was performed after each session. Response was assessed according to the RECIST criteria. Local tumor progression and overall survival were analyzed using Kaplan-meier and Cox hazard regression.

RESULTS

After evaluation of tumor response partial response (PR) was achieved in 11.3% (n=16), stable disease (SD) in 66.2% (n=94) and progessive disease (PD) in 22.5% (n=32). Mean survival time and time to progression were 24.3 months and 7.5 months respectively from the date of first intervention. The longest mean survival time was recorded in breast cancer patients with 28.4 months followed by colorectal cancer with 25 months. In the pallilative group mean survival was 19.4 months vs 30.4 months in the neoadjuvant group with subsequent ablation.

CONCLUSION

TPCE has the potential to improve local tumor control and to prolong survival with a neoadjuvant potential when ablation therapies are combined.

CLINICAL RELEVANCE/APPLICATION

Combined TPCE and ablation therapies can improve local tumor control and survival vs. TPCE alone.

SSA24-09 Visible Beads for Pulmonary Artery Embolization (PAE) - Proof of Principle

Sunday, Nov. 26 12:05PM - 12:15PM Room: E350

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PURPOSE

To analyze the degree of x-ray visibility of different types of microspheres for pulmonary artery embolization (PAE).

METHOD AND MATERIALS

Three different types of microspheres were analyzed: narrow-size calibrated 250µm-Embozene™, narrow-size calibrated 250µm-VISIBLE, and broad-size calibrated 100-300µm-DCBead™. Initially, in-vitro imaging applying MicroCT and human-scale CT was performed. Subsequently, 6 pigs underwent PAE of peripheral lung segments using the different types of microspheres. Thereby, the embolization endpoint was defined as delivery of a pure microsphere volume of 0.5 ml in each embolization position. After PAE, in-vivo human-scale DynaCT and CT followed, and subsequently sacrifice, lung harvest and preparation of paraffin blocks of the embolized lung segments. Representative paraffin blocks underwent ex-vivo imaging applying MicroCT. The study endpoint included the degree of x-ray visibility.

RESULTS

In-vitro imaging applying MicroCT and human-scale CT identified the lowest x-ray visibility for 250µm-Embozene™, the highest x-ray visibility for 250µm-VISIBLE, and a lack of x-ray visibility for 100-300µm-DCBead™. Ex-vivo imaging applying MicroCT identified the lowest x-ray visibility for 250µm-Embozene™, the highest x-ray visibility for 250µm-VISIBLE, and a lack of x-ray visibility for 100-300µm-DCBead™. Angiography after PAE documented occlusion of sub-segmental arteries for all types of microspheres. In-vivo imaging applying human-scale DynaCT and CT identified the highest x-ray visibility for 250µm-VISIBLE, and a lack of x-ray visibility for 250µm-Embozene and 100-300µm-DCBead™.

CONCLUSION

In this study, PAE with 250µm-Embozene™, 250µm-VISIBLE, and 100-300µm-DCBead™ results in a different degree of x-ray visibility of the microspheres.

CLINICAL RELEVANCE/APPLICATION

Potential clinical advantages of PAE applying 250µm-VISIBLE include better treatment control due to the high degree of x-ray visibility of the microspheres, and - when compared with 100-300µm-DCBead™ - controlled occlusion of arteries with a size closely corresponding to the nominal microsphere size (bronchiolus-associated arteries).

SSA25

Vascular Interventional (Ablation and Image Guided Interventions)

Sunday, Nov. 26 10:45AM - 12:15PM Room: E352

IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSA25-01 CT-Guided 125I Brachytherapy for Locally Recurrent Nasopharyngeal Carcinoma

Sunday, Nov. 26 10:45AM - 10:55AM Room: E352

Participants
Huzheng Yan I, PhD,PhD, Guangzhou, China (*Presenter*) Nothing to Disclose
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PURPOSE

The study evaluated the feasibility, clinical effectiveness, and quality of life of computed tomography (CT)-guided 125I brachytherapy for locally recurrent nasopharyngeal carcinoma (NPC).

METHOD AND MATERIALS

We recruited 81 patients diagnosed with locally recurrent NPC after previous radiotherapy with or without chemotherapy. Thirty-nine patients received 125I brachytherapy (group A) and 42 received re-irradiation (IMRT, group B). The evaluated outcomes were local control, complications, and quality of life. Cox proportional hazards regression analysis was used to compare local tumor progression-free survival (LTPFS) and overall survival (OS) in the two treatment groups.

RESULTS

The median follow-up was 30 months (range, 5-68 months), median LTPFS was 21 in group A and 17 months in group B. The 1-, 2-, and 3-year OS in group A were 84.6%, 51.3%, 30.7%, and 85.7%, 50.0%, and 32.6% in group B. In group A, 10/39 patients (25.6%) experienced at least one >=grade III complication; no grade V complications occurred. In group B, 28/42 (66.7%) experienced at least one >=grade III complication and 6/42 (14.3%) died of severe grade V complications. No significant between-group difference existed in the Quality of Life score on the EORTC QLQ-H&N35 questionnaire before treatment. In group A, quality of life was significantly improved after treatment; but did not improve, or even deteriorated in group B.

CONCLUSION

125I brachytherapy was a feasible, safe, and effective treatment for locally recurrent NPC. 125I brachytherapy significantly reduced complications caused by re-irradiation and improved patients' quality of life.

CLINICAL RELEVANCE/APPLICATION

enhanced MRI were obtained for the evaluation of curative effect at 1 month after treatment and then every 3 months.

SSA25-02 A Prospective Comparative Study on the Application of Microcoil and Hookwire For Localization of Small Pulmonary Nodules

Sunday, Nov. 26 10:55AM - 11:05AM Room: E352

Participants
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PURPOSE

To compare the efficacy and safety of preoperative localization technique using microcoil and hookwire for small pulmonary nodules.

METHOD AND MATERIALS

Fifty-four patients with 54 pulmonary lesions for preoperative localization enrolled in this study from October 2015 to March 2017. Inclusion criteria were as follows: (1) video-assisted thoracoscopic surgical (VATS) intended;(2) radiological features match :1) pulmonary nodules <20 mm;2) lesions locating in the 1/3 peripheral part of the lung with feasibility of wedge resection or segmentectomy;3) without pleural retraction sign; (3)agree to be enrolled in this study and sign informed consent. All the patients

were randomly assigned to two groups. The 27 patients in Group A underwent CT-guided percutaneous localization procedure with microcoil on the day of operation; the other 27 patients in Group B underwent CT-guided percutaneous localization procedure with hookwire on the day of surgery. The primary outcomes were procedure success rate and complication rate.

RESULTS

VATS were successfully performed in all the cases, with no conversion to thoracotomy. The procedure success rate was 96.2% (26/27) in Group A and 92.6% (25/27) in Group B (P>0.05). The complication rate was 18.5% (5/27) in Group A; asymptomatic pneumothoraces occurred in 3 patients and mild pulmonary hemorrhage occurred in 2 patients. The complication rate was 51.8% (14/27) in Group B; asymptomatic pneumothoraces occurred in 11 patients and mild pulmonary hemorrhage occurred in 2 patients and chest pain requiring medical intervention occurred in 1 patient(P<0.05).

CONCLUSION

Both microcoil and hookwire have been proved to be effective in preoperative CT-guided percutaneous localization for small pulmonary nodule. Localization procedures with microcoil were associated with fewer complications and more advantages in clinical application.

CLINICAL RELEVANCE/APPLICATION

Localization procedures with microcoil were associated with fewer complications and more advantages in clinical application and is recommended as the optimal method.

SSA25-03 Innovative Technique for CT-Guided Lung Nodule/Tumor Marking Prior to Surgery: High Efficacy and Low Complication Rates

Sunday, Nov. 26 11:05AM - 11:15AM Room: E352

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PURPOSE

To assess outcomes of CT-guided localization for preoperative lung nodule marking prior to video-assisted thoracoscopic surgery and robotic video-assisted thoracoscopic surgery.

METHOD AND MATERIALS

24 CT guided lung nodule localization procedures were performed on 24 nodules in 24 patients prior to surgical resection. The procedures were performed by a fellowship trained radiologist 1 to 2 hours prior to scheduled surgery under local anesthesia. Approximately 4 to 6 ml of methylene blue/ collagen solution was injected in the perinodular location under CT-guidance with a 19 g trocar needle. Post procedure CT was performed and the patient was transferred to surgery.

RESULTS

Accurate perinodular CT- guided needle trocar placement was achieved in all marking procedures. Increased perinodular consolidation was demonstrated in all patients on the post procedural CT scans. One patient with moderate emphysema developed a small to moderate sized pneumothorax and a 8F thoracentesis catheter was placed under CT guidance prior to return to surgery. A second patient developed a tiny pneumothorax which was managed with non-rebreather oxygen mask. There was no noted bleeding or hemoptysis in any patient. Methylene blue/ collagen solution was readily visible by the thoracic surgeon in 23 patients (94%). In one patient, the methylene blue/ collagen was not visualized by the surgeon or present in specimen, although post-marking CT demonstrated perinodular consolidation. Of the 23 identified nodules, pathology specimens confirmed adequacy of nodule resection in all cases.

CONCLUSION

Intraoperative identification of pulmonary nodules/ tumors, especially deep nodules and patients undergoing VATS or robotic surgery, may be challenging. Perinodular localization by CT guided methylene blue/ collagen solution injection offers a low-cost, safe technique with high efficacy.

CLINICAL RELEVANCE/APPLICATION

CT-guided methylene blue/ collagen localization allows thoracic surgeons to readily identify nodules/tumors, improve outcomes and decrease morbidity in patients undergoing thoracic surgery.

SSA25-04 Intraarterial Chemoperfusion (IACP) for Treatment of Irresectable Chest Wall or Lymph Node Recurrence of Breast Cancer Not Amenable to Radiation Therapy

Sunday, Nov. 26 11:15AM - 11:25AM Room: E352

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PURPOSE

About 10% of breast cancers recur locally after mastectomy. Depending on the type of prior radiotherapy, chest wall recurrences are not amenable to resection or radiation therapy. For these patients, intraarterial chemoperfusion (IACP) is a treatment option. We report on our long-term experiences with IACP depending on type of breast cancer (luminal vs. basal).

METHOD AND MATERIALS

11 women (32-84 years) with chest-wall (n=3) or loco-regional lymph-node recurrence (n=7) or both (n=1), of basal-type (triple-negative) breast cancer in 4, and of luminal-A/B-type in 7. IACP was performed superselectively via the internal thoracic artery, or an axillary artery branch using a perfusor-guided infusion of 30 mg mitoxantrone via mirocatheter. IACP was repeated every 3 weeks depending on tumor response and leukocyte-count. MRI/CT was performed prior to each IACP-session and every 3 months during follow-up. Local control was defined as CR, PR, or SD.

RESULTS

Five patients underwent 4 IACP-sessions, 2 patients had 3, and 4 had a single IACP-session. CR was achieved in 4/11, PR in 4/11, SD in 3/11, and PD in 0/11, yielding a local-control-rate of 11/11 (100%). Of the 8 responders, 6 (75%) were Luminal-A/B-type, of the 3 non-responders, 2 (66.7%) were basal-type cancers. 4/8 responders demonstrated long-term (>36 months) CR; all four had luminal-A/B-type. 2/3 non-responders died <2 months after therapy initiation. One patient experienced a major side-effect (cardiac-decompensation); minor side-effects occurred in 3/11 patients.

CONCLUSION

For patients with unresectable, locally recurrent luminal-A/B-type breast cancers not amenable to radiation therapy, IACP can offer long-term local-control, or even complete remission, with minimal side effects.

CLINICAL RELEVANCE/APPLICATION

IACP is a valuable treatment option for patients with local recurrent luminal-A/B-type breast cancer.

SSA25-05 Prospective Clinical Trial for Uterine Adenomyosis Using Portable Ultrasound-guided High Intensity Focused Ultrasound: Interim Results

Sunday, Nov. 26 11:25AM - 11:35AM Room: E352

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PURPOSE

To investigate the efficacy and safety of a new portable compact ultrasound-guided high intensity focused ultrasound (USgHIFU) with advanced targeting and beam steering technology for the treatment of uterine adenomyosis

METHOD AND MATERIALS

This prospective study was approved by the institutional review board, and informed consent was obtained from all participants. Fifty-one uterine adenomyoses from 51 patients (mean age, 44.1 ± 4.2 years) were included. All patients were treated with HIFU with 3D electronic steering. MR imaging studies were performed before HIFU, immediately after HIFU, and 1 month, and 3 months. The non-perfused volume ratio (NPVR), Adenomyosis volume shrinkage rate (AVSR), dysmenorrhea improvement index (1, complete relief; 3, minor relief; 5, exacerbated pain), treatment time and safety were analyzed.

RESULTS

The mean volume of the treated uterine adenomyoses was 125.0 ± 129.2 cm3. The mean NPVR on the immediate post-HIFU MR imaging was 59.6 ± 36.1%. The mean AVSR was 17.8% at 1 month, and 36.1% at 3 months after HIFU treatment. The mean time taken to treat was 94.6 ± 33.7 minutes per patient. Complete relief of dysmenorrhea was identified in 15.2% and 34.2% of treated patients, 1 month and 3 months after HIFU treatment, respectively. The mean dysmenorrhea improvement index was 2.5 and 2.1, 1 month and 3 months after HIFU treatment, respectively. No significant symptoms related to safety or complications occurred

CONCLUSION

The interim results of our clinical trial showed that USgHIFU may be effective and safe for the treatment of uterine adenomyosis.

CLINICAL RELEVANCE/APPLICATION

Ultrasound-guided HIFU with advanced functions may be effective and safe for the treatment of uterine adenomyosis.

SSA25-06 Flow Mediated Dilatation (FMD) Assessment via an MRI Integrated Signal Intensity (IntSI) Approach: A Comparison with Ultrasound

Sunday, Nov. 26 11:35AM - 11:45AM Room: E352

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PURPOSE

To demonstrate that flow mediated dilatation using an integrated signal intensity MRI approach for serial area measurements is more repeatable than ultrasound based flow mediated dilatation.

METHOD AND MATERIALS

An integrated signal intensity MRI approach was used to perform flow mediated dilatation (MRI-FMD) in 19 healthy volunteers. The test-retest repeatability of popliteal MRI-FMD using the integrated signal intensity (IntSI) technique was compared with that of brachial and popliteal ultrasound FMD.

RESULTS

There was moderate agreement between brachial US-FMD and popliteal US-FMD (r: 0.59). The mean difference between the baseline areas of the popliteal artery using MRI versus US was 4.76 ± 5.19 mm2, which is a difference of 19 % relative to the US baseline area. The mean difference between popliteal US-FMD and MRI-FMD was 5.07%. The within subject coefficient of variability of the popliteal MRI-FMD technique at 17% was comparable with both the brachial ultrasound and popliteal ultrasound FMD techniques (16 % and 18% respectively).

CONCLUSION

MRI-FMD using the IntSI technique provides an alternative method of measuring macrovascular endothelial function.

CLINICAL RELEVANCE/APPLICATION

Ultrasound has high temporal and spatial resolution so it is suitable for detecting transient changes in the vessel calibre during FMD. However, it is operator dependent, therefore may not be suitable for multicenter studies. MRI on the other hand is less operator dependent so can be used for multicenter studies. Current MRI techniques for measuring FMD require high resolution because the luminal area is measure by pixel counting, but there is a trade off between spatial and temporal resolution, which limits the temporal sampling frequency. FMD assessment using the integrated signal intensity approach provide a means of obtaining serial measurements of the artery during the vasodilatory response.

SSA25-07 Long-Term Outcome of RF-Ablation for Non-Resectable Recurrence of Colorectal Liver Metastases in the Liver Remnant after Prior Hepatic Resection

Sunday, Nov. 26 11:45AM - 11:55AM Room: E352

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PURPOSE

To evaluate the outcome of patients treated with radiofrequency ablation (RFA) for non-resectable hepatic recurrence of colorectal liver metastases (CRLM) in patients initially treated surgically with curative intent.

METHOD AND MATERIALS

19 consecutive patients (10 male, 9 female) who underwent CT-guided RFA for recurrent, non-resectable CRLM of the liver remnant after hepatic resection were included. Patients with a maximum of three metastases measuring up to 3 cm and without relevant extrahepatic disease were considered candidates for RFA. In addition to local ablation, all patients received adjuvant chemotherapy and were re-treated by local ablation during the follow-up period whenever appropriate. Patient and treatment related data were analyzed retrospectively; progression-free-survival (PFS) and overall survival (OS) rates after the first RF-ablation were determined. Median follow-up was 21 months (range 12-80 months).

RESULTS

Mean time interval between hepatic resection and percutaneous ablation of hepatic tumor recurrence was 7.6 +/-7.5 (SD) months. In 3 of the 19 patients, tumor recurred at the surgical resection margin, the remaining 16 patients were treated for metastases that had recurred elsewhere in the liver remnant. After RFA, median PFS was 7 months (n=19, range 1-81 months). The 1-year-OS-rate was 100% (19/19), the 3-year-OS-rate was 50% (n=6/12 - 7 patients had a follow-up of less than 3 years) and the 5-year-OS-rate was 17% (n=2/12). 10 patients developed recurring intrahepatic disease after treatment with RFA. Of these 10 patients, one patient developed local tumor recurrence at the ablation site, while the remaining 9 patients developed new metastases elsewhere in the liver. Minor peri-interventional complications occured in two patients and included segmental cholestasis adjacent to the ablation zone in one patient and a small basal pneumothorax and minor hemorrhage into the ablation zone in one other patient. Both patients were asymptomatic and managed conservatively.

CONCLUSION

Overall survival rates support the use of secondary RF-ablation for treatment of hepatic recurrence of non-resectable CRLM after initial hepatic resection.

CLINICAL RELEVANCE/APPLICATION

In patients with local intrahepatic recurrence after hepatic surgery for CRLM, RFA should be an integral part of a multimodality treatment regimen.

SSA25-08 Utilization of Interventional Oncologic Therapies for Patients Referred to a Primary Liver Tumor Board at a Tertiary Care and Liver Transplant Center

Sunday, Nov. 26 11:55AM - 12:05PM Room: E352

Participants
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PURPOSE

To characterize the utilization of interventional oncologic (IO) therapies for patients referred to a primary liver tumor board at a tertiary care and liver transplant center.

METHOD AND MATERIALS

A retrospective chart review was performed on all patients referred to a primary liver tumor board at a single tertiary care and liver transplant center from January 1, 2013 to December 31, 2015. The board is a multidisciplinary board consisting of diagnostic and interventional radiologists, transplant surgeons, surgical oncologists, gastroenterologists, hepatologists, pathologists, and medical and radiation oncologists. The number and dates of the following treatments were noted: ablation, radioembolization (Y90), transarterial chemoembolization (TACE), bland embolization (TAE), systemic therapy, surgery/resection, liver transplantation, radiation, or nothing/palliative care. Interventional oncologic therapies included ablation, Y90, TACE and TAE. The number of patients with treatable lesions (primarily HCC or cholangiocarcinoma) undergoing each type of treatment were calculated, as was the percentage of patients undergoing IO therapies and the mean number of IO treatments per patient.

RESULTS

Of the 729 patients referred to the liver tumor board, 299 had at least one treatable liver lesion and underwent a total of 523 oncologic treatments. The remainder had indeterminate lesions, benign tumors or no evidence of disease. Of the 299 patients with treatable lesions, 74% (221/299) underwent at least one IO therapy and 70% (208/299) underwent an IO therapy as first line treatment. The mean number of IO treatments was 1.2 per patient (range, 1-5) for a total of 368 IO treatments performed. The most frequently performed IO therapy was thermal ablation (48% of all IO treatments), followed by TACE (25%), Y90 (20%), and TAE (7%). Ablation was also the most common IO treatment used as first line therapy (53%), followed by Y90 (23%), TACE (18%), and TAE (6%). The most frequently used non-IO treatments were surgical resection and liver transplantation (12%, 37/299 patients each).

CONCLUSION

Interventional oncology plays a pivotal role in managing patients with primary liver tumors with the majority of patients with treatable lesions undergoing at least one IO therapy.

CLINICAL RELEVANCE/APPLICATION

Interventional oncologists must play an active role in multidisciplinary groups and tumor boards that determine patient referrals and treatment pathways.

SSA25-09 Microwave Ablation and Radiofrequency Ablation for Treatment of Hepatocellular Carcinoma: Result of a Prospective Randomized Controlled Trial

Sunday, Nov. 26 12:05PM - 12:15PM Room: E352

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PURPOSE

In a prospective randomized controlled multi-centric study, we compared rate of local tumor progression and survival in patients with chronic liver disease with hepatocellular carcinoma (HCC) <4cm treated either by microwave ablation (MWA) or by radiofrequency ablation (RFA).

METHOD AND MATERIALS

Patients with chronic liver disease having HCC with <=3 lesions of <=4cm, BCLC stage A, not eligible for surgery were prospectively randomized from 2011 to 2015. Final RFA group (open arm) consisted in 73 patients with 104 lesions ablated (11 females, 53 patients with Child-Pugh A) and final MWA group (Acculis) consisted in 71 patients with 98 lesions ablated (12 females, 57 patients with Child-Pugh A). Rate of local tumor progression (LTP) at two years of follow-up in intention-to-treat analysis was the primary outcome. Time to progression (TTP), survival, incomplete treatment rate and safety constituted the secondary outcomes. Groups were compared using unpaired T-test and Chi-square test depending of the type of data. Survival analysis was made using Kaplan-Meier curves.

RESULTS

Patient groups were similar for demographic, biology and tumor characteristics (mean lesion size was 18mm in both groups). LTP at two-year follow up was not different between the two groups (RFA: 11.5%; MWA: 6%, p=0.27). TTP was similar (RFA 16 months (SD:6.5) and MWA 12 months (SD:8.2); p=0.28), confirmed by analysis with competition risk and inverse probability of censoring weighting analyses accounting for transplantation or death. Survival at two years was not different: RFA group 87%, MWA group 89% (p=0.78). Rate of complication was low with two grade 4 complications (SIR classification), both in MWA group.

CONCLUSION

This prospective randomized study with patients with HCC <=4cm treated either by RFA or MWA evidenced no difference in local tumor progression and survival at two-year follow-up.

CLINICAL RELEVANCE/APPLICATION

MWA has theoretical advantages over RFA: shorter ablation time, higher temperature of ablation, reduction of heat-sink effect and treatment of larger lesions. Our study demonstrates that MWA does not add clinical benefit over RFA for LTP and survival at two years.

SSC01

Cardiac (Non-ischemic Cardiomyopathy and Myocarditis)

Monday, Nov. 27 10:30AM - 12:00PM Room: S502AB

CA MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Tina D. Tailor, MD, Durham, NC (*Moderator*) Research support, General Electric Company

Sub-Events

SSC01-01 Noninvasive Hematocrit Assessment for Cardiac MRI Extracellular Volume Fraction Quantification Using a Point of Care Device and Synthetic Derivation

Monday, Nov. 27 10:30AM - 10:40AM Room: S502AB

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate noninvasive measures of hematocrit (Hct) for cardiac MRI extracellular volume (ECV) quantification using a noninvasive point of care (POC) device and synthetic derivation, with laboratory Hct as the reference standard.

METHOD AND MATERIALS

In this prospective IRB approved study, 129 subjects (46% male, 47.4±13.4 years) underwent cardiac MRI T1 mapping at 1.5T (n=83) and 3T (n=46) using MOLLI (n=118) or ShMOLLI (n=11). Laboratory Hct values were obtained by venipuncture within 24 hours. Same day noninvasive hemoglobin values were acquired utilizing a POC device (Pronto-7, Masimo, Irvine, California, USA) with a 0.3 conversion to Hct. Three test-retest POC values were obtained in a subgroup of patients (n=44). Synthetic hematocrit was derived from pre-contrast blood pool R1 using previously published conversions in the subgroup at 1.5T. Left ventricular ECV was calculated based on pre- and post-contrast T1 values and input of laboratory Hct (ECV-lab), POC Hct (ECV-POC), and synthetic Hct (ECV-synthetic), respectively.

RESULTS

There was no significant difference between laboratory and POC Hct (0.397±0.050 vs. 0.395±0.047, p=0.532) or ECV (27.3±4.7 vs. 27.4±4.8, p=0.451) with excellent correlation between measures (Hct r=0.81, p=<0.001 and ECV r=0.92, p=<0.001). There was no significant difference between laboratory and synthetic Hct (0.395±0.031, p=0.073) or ECV (26.7±4.1, p=0.084) with good correlation between measures (Hct r=0.66, p=<0.001 and ECV r=0.90, p=<0.001). Bland-Altman analysis demonstrated minimal bias for ECV-POC (bias= -0.15%, 95%CI[-2.2, 2.3]) and ECV-synthetic (bias=0.22%, 95%CI[-1.82, 2.7]) compared to ECV-lab. Excellent diagnostic performance was achieved for ECV-POC (area under the curve (AUC) 0.909, 95%CI[0.840, 0.977]) and ECV-synthetic (AUC 0.852, 95%CI[0.734, 0.970]) for discriminating ECV-lab≥30%, with no significant difference in AUC between the two noninvasive measures (p=0.485). There was excellent test-retest agreement for ECV-POC (ICC 0.977, 95%CI[0.963, 0.987]).

CONCLUSION

Myocardial ECV calculated using noninvasive measures of Hct correlates strongly with conventionally calculated ECV using laboratory Hct values with minimal bias.

CLINICAL RELEVANCE/APPLICATION

Myocardial ECV derived from noninvasive measures of Hct is accurate and reproducible, eliminating the need for blood collection by venipuncture and potentially improving patient comfort and safety.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality

educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Kate Hanneman, MD, FRCPC - 2017 Honored Educator

SSC01-02 Regional Ventricular Dysfunction Differs In Cardiac Sarcoidosis and Arrhythmogenic Right Ventricular Dysplasia/Cardiomyopathy: Assessment by MRI Strain Analysis

Monday, Nov. 27 10:40AM - 10:50AM Room: S502AB

Awards
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PURPOSE

Myocardial sarcoidosis is the most common 'missed' diagnosis in patients evaluated for arrhythmogenic right ventricular dysplasia/cardiomyopathy (ARVD/C). The purpose of this study was to investigate the utility of left and right ventricular strain analysis by cardiac MRI (CMR) in distinguishing these two entities.

METHOD AND MATERIALS

68 patients who were consecutively screened for ARVD/C between 2009-2011 and fulfilled diagnostic criteria for ARVD/C were obtained by retrospective chart review. An additional 21 sarcoidosis who fulfilled 2014 Heart Rhythm Society consensus recommendations were identified from a review of consecutive patients who underwent CMR to screen for cardiac sarcoidosis during the same time interval. Regional and global systolic strain analysis was performed on cine SSFP CMR images (Myocardial Tissue Tracking, Toshiba). Global and segmental right ventricular (RV) and left ventricular (LV) longitudinal strains were measured on 4-chamber long axis views and circumferential strains on short-axis views. RV regional strain was divided into basal, mid, and apical segments. LV strain was analyzed according the standard 17 segment model.

RESULTS

Overall 47 men and 42 women were studied (mean age: 53±19 years). There were no significant differences in age and sex between the two groups. Sarcoidosis patients had significantly worse LV systolic longitudinal strain both globally (-16±6 vs -22±7, $p<0.001$) and in the basal septum (-11±8 vs -18±7, $p<0.001$). In contrast, ARVD patients had significantly worse RV systolic longitudinal strain both globally (-16±9 vs -20±8, $p=0.03$) and in the basal free wall (-23±7 vs -29±13, $p=0.03$). Similar differences between groups were seen for circumferential RV and LV systolic strain measures. There were no significant strain differences for the other segments of the RV and LV.

CONCLUSION

Regional and global longitudinal strain patterns are markedly different in patients with sarcoidosis versus ARVD/C as assessed by feature tracking CMR strain analysis.

CLINICAL RELEVANCE/APPLICATION

Sarcoidosis and ARVD/C have considerable overlap in clinical and imaging features. RV and LV strain analyses with CMR may provide additional information to help facilitate distinguishing these diseases when the diagnosis is unclear.

SSC01-03 Trastuzumab and Anthracycline-Induced Cardiotoxicity: Evaluation with Contrast-Enhanced T1 Mapping Cardiovascular Magnetic Resonance Imaging, and Histological Findings

Monday, Nov. 27 10:50AM - 11:00AM Room: S502AB

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PURPOSE

Cardiotoxicity is a notorious adverse effect of anthracycline agents and trastuzumab. This study was designed to investigate serial

myocardial change owing to cardiotoxicity by using T1 mapping cardiovascular magnetic resonance imaging and cardiotoxicity rat models.

METHOD AND MATERIALS

Twenty-three rats were assigned to one of three groups (control group: n = 5, trastuzumab group: n = 8, trastuzumab + doxorubicin group: n = 10). These received one of the following treatment drug regimens administered intravenously through the tail vein: (1) saline control, 0.9% (n = 5), (2) trastuzumab, 8 mg/kg once a week, and (3) trastuzumab, 8 mg/kg followed by doxorubicin (2 mg/kg) once a week (n = 8). Cine, pre-contrast, and post-contrast T1 mapping sequences were performed by using a 9.4-T magnetic resonance scanner every 4 weeks after drug administration until 12 weeks. After 8 or 12 weeks, the hearts were processed for pathological analysis.

RESULTS

In normal control subjects, the measured ejection fraction (EF), native T1, and extracellular volume fraction (ECV) of the left ventricle were 72.05%, 1190 ms, and 15.03%, respectively. In the trastuzumab group, the EF, native T1, and ECV did not significantly change in accordance with the modeling time (4 vs. 8 vs. 12 weeks) as follows: EF, 68.02% vs. 66.19% vs. 68.53% (p = 0.131); native T1, 1235.8 vs. 1238.83 vs. 1198.63 ms (p = 0.323); and ECV, 16.12% vs. 17.96% vs. 18.55% (p = 0.609). In the trastuzumab + doxorubicin group, EF decreased significantly according to the modeling time (64.55% vs. 56.00% vs. 37.25%, p = 0.008), whereas native T1 and ECV increased in accordance with the modeling time (native T1: 1245.75 vs. 1238.02 vs. 1273.9 ms, p = 0.145; ECV: 15.85% vs. 22.12% vs. 25.15%, p = 0.034). Histological examination revealed, a mild interstitial edema in the left ventricular myocardium in the trastuzumab group (n = 4) and a significant myocardial fibrosis in the trastuzumab + doxorubicin group (n = 6).

CONCLUSION

T1 mapping CMR imaging may be the useful noninvasive monitoring method tool for anthracycline-associated and trastuzumab-associated cardiotoxicity owing to its comprehensive nature of myocardial tissue characterization.

CLINICAL RELEVANCE/APPLICATION

T1 mapping CMR imaging can demonstrate subclinical anthracycline-associated and trastuzumab-associated cardiotoxicity and is recommended as a useful noninvasive monitoring method.

SSC01-04 T2-Weighted Short Tau Inversion Recovery Image of Cardiac Magnetic Resonance Reflects Disease Activity of Cardiac Involvement of Sarcoidosis: Comparison with Conventional Methods

Monday, Nov. 27 11:00AM - 11:10AM Room: S502AB

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PURPOSE

Accurate evaluation of disease activity of cardiac involvement of sarcoidosis (CIS) is critical for treatment planning. We investigated whether high signal intensity on T2-weighted short tau inversion recovery image (T2W-STIR-BB) of cardiac magnetic resonance (CMR) is useful in evaluating CIS activity.

METHOD AND MATERIALS

18F-fluorodeoxyglucose positron emission tomography(FDG-PET), CMR, 67Gallim-schintigraphy, echocardiogram, electrocardiogram (ECG) and biomarkers (angiotensin-converting enzyme, soluble interleukin-2 receptor, lysozyme) were obtained within 3 months for patients who met at least one major and one minor criterion of the 2016 guidelines of diagnosis of cardiac sarcoidosis by the Japanese circulation society that upgrade late gadolinium enhancement of CMR and positive uptake of FDG by the myocardium to major criteria. We measured the spleen to myocardium ratio (SMR) of signal intensity for quantitative analysis of T2W-STIR-BB, with SMR above 0.58 considered positive based on our previous investigation. We determined CIS activity based on positive uptake of FDG by the myocardium. Maximum standard uptake value (SUV-max) of 2.5 and above was defined as significant uptake of FDG.

RESULTS

Of 28 patients with CIS (14 men, 65.4±15.0 years), 17 demonstrated positive findings on FDG-PET (SUV-max, 5.11±3.51);19,on T2-STIR-BB (SMR, 0.64±0.13); three, on 67Gallium-schintigraphy; six, on biomarkers; and 20, on ECG. Sensitivity, specificity, accuracy, positive, and negative predictive values for diagnosing CIS activity using positive uptake of FDG by the myocardium as a gold standard were 87.5%, 60.0%, 76.9%, 77.8%, 75.0% for T2W-STIR-BB; 21.4%, 100.0%, 50.0%, 100.0% and 42.1% for 67Gallium-schintigraphy; 20.0%, 66.7%, 37.5%, 50.0%, and 33.3% for biomarkers and 78.6%, 30.8%, 55.6%, 55.0% and 57.1% for

ECG.

CONCLUSION

Although specificity was higher in 67Gallium schintigraphy, the sensitivity and accuracy of T2W-STIR-BB were better than those of 67Gallium schintigraphy, biomarkers and ECG findings. T2W-STIR-BB is more useful than conventional methods for evaluating disease activity in CIS.

CLINICAL RELEVANCE/APPLICATION

T2W-STIR-BB reflects disease activity of cardiac involvement of sarcoidosis with better accuracy compared with those of conventional methods and is recommended in the initial evaluation.

SSC01-05 Association of Imaging Markers of Diffuse Myocardial Fibrosis by CMR T1ρ Mapping and T1 Mapping with Myocardial Diastolic Function in Rhesus Monkeys with Spontaneous Type 2 Diabetes Mellitus

Monday, Nov. 27 11:10AM - 11:20AM Room: S502AB

Participants
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PURPOSE

To investigate the relationship of myocardial fibrosis and diastolic dysfunction in a rhesus monkey model with early type II diabetes mellitus. Imaging biomarkers of ECV and a new non-contrast myocardial fibrosis index were used to determine myocardial fibrosis content.

METHOD AND MATERIALS

A total of 19 male rhesus (14.27years±2.22years, 10.1kg±1.98kg) monkeys were studied. Fourteen of them were spontaneous type 2 diabetes mellitus (T2DM, FPG>104mg/dl, HbA1c: 4.5-7.3%). The other five controls (HC, FPG<90mg/dl) are matched in age, weight and gender. Blood biochemical examination was tested during the four-week acclimation. CMR protocol included: cine, T1ρ mapping (TR = 640 ms, TE = 1.45 ms, FA = 7, bandwidth = 1002 Hz/Px, FOV = 160mm x 160 mm, voxel size = 2.2 mm x 1.7 mm x 5.0 mm, slice thickness = 5 mm , spin-locking frequency (SLF) = 510 Hz or 0 Hz, time of spin-locking (TSL) = 10, 30, 50 ms),T1 mapping, and LGE. All images were acquired during a breath-hold time by turning off ventilation for 15-20 sec. Pre-T1, post-T1 and extracellular volume (ECV) values were acquired using software available in the MRI system. Myocardial fibrosis index (mFI), which is a new non-contrast myocardial fibrosis index calculated based on the dispersion characteristics of T1ρ, and absooute T1ρ values were calculated. Cardiac function was calculated using cine images. One heart was harvested from a diabetic monkey with diastolic dysfunction after imaging. HE and Masson staining were performed to confirm diffuse myocardial fibrosis.

RESULTS

Echocardiographic results show all 14 monkeys in T2DM have diastolic dysfunction (8 monkeys in T2DM is E/A<1,E'/A' >1; the other 6 in T2DM is E/A>1,E'/A' <1), whereas E/A>1,E'/A' >1 in all 5 controls. MRI results and the association between MRI marker for myocardial fibrosis and diastolic dysfunction shows in Table 1. For focal fibrosis, there was no evidence of regional late contrast enhancement in all animals. Histopathology showed that the myocardial extracellular space was widened with diffuse fibrosis with ECV = 37.46% and mFI =5.85 in this diabetic monkey.

CONCLUSION

CMR drevied myocardial fibrosis markers (ECV and mFI) are associated with diastolic dysfunction in T2DM monkeys but not an independent determiner for it.

CLINICAL RELEVANCE/APPLICATION

For diabetic cardiomyopathy therapy maybe we can target both myocardial fibrosis and diastolic at the same time.

SSC01-06 Quantitative Parameters Using Cardiovascular Magnetic Resonance for Differential Diagnosis of Cardiac Amyloidosis and Hypertrophic Cardiomyopathy: Comparison of Inversion Time to Native T1 and Extracellular Volume

Monday, Nov. 27 11:20AM - 11:30AM Room: S502AB

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PURPOSE

The purpose of this study was to explore the quantitative CMR parameters such as inversion time (TI), native T1, and extracellular volume (ECV) for differential diagnosis between cardiac amyloidosis (CA) and hypertrophic cardiomyopathy (HCM).

METHOD AND MATERIALS

We included 46 patients with biopsy-confirmed CA and 22 consecutive patients with clinically diagnosed HCM from our CMR registry. Ten healthy subjects were also included for reference value. All patients underwent CMR examination using 1.5T system. T1 values were measured by drawing region of interest (ROI) in left ventricle (LV) septum and cavity on pre- and post-contrast T1 mapping to obtain native T1 and ECV values. TI values were also measured using same method on TI scouts images, which were acquired at 10 minutes after contrast injection. TI values were selected at nulling point of each LV septum and cavity. The interval of TI was calculated to show time difference of nulling points of LV septum and cavity. Comparison of continuous variables of three groups

was performed using Kruskal Wallis test. The diagnostic performance of TI interval for CA diagnosis was compared to native T1 and ECV using area under the receiving operating characteristics curve (AUC).

RESULTS

Native T1 values of CA, HCM, and control groups were significantly different (1176.35 ± 261.15 vs. 1060.62 ± 46.71 vs. 971.17 ± 68.67 ms, p <0.001). ECV values of three groups were significantly different (52.47 ± 14.73 ms vs. 26.94 ± 3.89 vs. 26.04 ± 4.83, p <0.001). The TI interval values of three groups were significantly different (-5.3 ± -0.9 vs. 62.9 ± 27.6 ± 83.9 ± 1.7 ms, p <0.001). On AUC analysis, the AUC values of TI interval and ECV were significantly different to that of native T1 for different diagnosis between CA and HCM (AUC: 0.924 vs. 0.821, p =0.035 in TI interval vs. native T1 and 0.941 vs. 0.821, p =0.008 in ECV vs. native T1). The diagnostic performance of TI interval was not inferior to that of ECV (AUC: 0.924 vs. 0.941, p =0.514).

CONCLUSION

The diagnostic performance of TI interval of LV septum and cavity shows superior that of native T1 and non-inferior to that of ECV for differential diagnosis between CA and HCM.

CLINICAL RELEVANCE/APPLICATION

The interval s of inversion time of LV septum and cavity can be quantitative CMR parameters for CA diagnosis without the need to obtain further mappings.

SSC01-07 Left and Right Ventricular Cardiac MRI T1 mapping at 3T Differentiates Anderson-Fabry Disease from Hypertrophic Cardiomyopathy

Monday, Nov. 27 11:30AM - 11:40AM Room: S502AB

Awards
Student Travel Stipend Award

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PURPOSE

To compare 3T cardiac MRI left ventricular (LV) and right ventricular (RV) T1 values in patients with Anderson-Fabry disease (AFD) and hypertrophic cardiomyopathy (HCM).

METHOD AND MATERIALS

In this prospective study, non-contrast cardiac MRI T1 mapping was performed at 3T using a modified Look-Locker inversion recovery (MOLLI) technique in patients with gene-positive AFD (n=14, 36% male, 43.36±15.06 years, 29% on enzyme replacement therapy) and HCM (n=25, 84% male, 49.48±12.11 years). Cine SSFP and late gadolinium enhancement (LGE) imaging were also performed. Same day hematocrit values were used for calculation of LV extracellular volume (ECV).

RESULTS

LV ejection fraction (p=0.950), LV mass (p=0.169), RV ejection fraction (p=0.472) and RV mass (p=0.626) were not significantly different between AFD and HCM. There was no statistically significant difference in the presence of non-hinge point LGE between AFD and HCM (57% vs. 79%, p=0.799). However, the presence of basal inferolateral LGE was more common in AFD compared to HCM (29% vs. 4%, p=0.028). Non-contrast myocardial T1 values (excluding areas of LGE) were significantly lower in AFD compared to HCM for both LV (1140.0±48.0ms vs. 1251.6±39.8ms, p<0.001) and RV (1234±82.6ms vs. 1331.5±131.6ms, p=0.020). LVECV did not differ significantly between AFD and HCM (24.5±1.9% vs. 24.1±3.0%, p=0.705). A non-contrast LV T1 cut-off value of ≤1190ms distinguished AFD from HCM with sensitivity 92% and specificity 96% (AUC 0.944, 95%CI [0.864, 1.00]). In a multivariable logistic regression model, LV non-contrast T1 values have independent value over other conventional imaging parameters (LV mass, basal inferolateral LGE, apical-basal muscle bundle and myocardial crypt) and age to differentiate AFD from HCM (OR 0.92, 95%CI [0.86, 0.99], p=0.019). In a nested logistic regression model with age and conventional imaging parameters, model fit is significantly improved by the addition of LV non-contrast T1 values (p<0.001).

CONCLUSION

Non-contrast cardiac MRI T1 values at 3T are significantly lower in patients with AFD compared to HCM and provide independent and incremental diagnostic value beyond traditional imaging features.

CLINICAL RELEVANCE/APPLICATION

Distinguishing myocardial hypertrophy related to AFD and HCM is a clinical and imaging challenge. Non-contrast T1 mapping provides incremental diagnostic value beyond traditional imaging features.

SSC01-08 Persistence of Late Gadolinium Enhancement in Imaging Post-Acute Myocarditis

Monday, Nov. 27 11:40AM - 11:50AM Room: S502AB

Participants
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PURPOSE

To demonstrate the persistence of late gadolinium enhancement (LGE) during follow-up cardiac magnetic resonance (CMR) in asymptomatic patients with previous acute myocarditis (AM), confirmed by CMR.

METHOD AND MATERIALS

Between 2008 to 2016 thirty-three consecutive patients with clinical and laboratory suspicion of AM were included in the study. They were referred for CMR after seven days from the beginning of the clinical examination. CMR was performed at 1.5T, using a standard protocol: SSFP sequences in cine mode; black blood STIR T2 sequences in the short ventricular axis; T1 sequences with and without gadolinium (DOTA) to study early enhancement and LGE (at least 10 minutes after contrast injection).

RESULTS

Patients were 31±11 y.o. (91% males). Thirty one (94%) had CMR-confirmed AM. All thirty-three (100%) patients initially had either patchy or diffuse subepicardial and/or transmural edema in the T2 sequences and LGE corresponding with the areas of edema. LGE was typically localized to the sub-epicardial region of the left ventricle (LV) and extended to a variable extent through the ventricular wall, inferolaterally and less frequently to the anteroseptal segments. Sometimes it was distributed in a multi-focal or diffuse way. Twenty were referred for follow-up CRM three or six months later. None of the patients had edema during follow-up CRM, but in sixteen (52%) LGE persisted. Four (13%) referred for repeat follow-up, three years after being diagnosed of AM still had LGE without symptoms.

CONCLUSION

There is not a perfect correlation between clinical conditions (including a complete recovery of the global cardiac functionality) of the patients and imaging post-myocarditis. This study confirms that the presence and the extent of LGE in CMR follow-up are not predictive of outcome in patients without severe hemodynamic compromise and a CMR-based diagnosis of AM.

CLINICAL RELEVANCE/APPLICATION

Sub-epicardial LGE is frequently (52%) observed in patients with previous AM and it is not associated with hemodynamic compromise or/and poor clinical conditions.

SSC01-09 Right Ventricular Hemodynamics in the Course of Acute Myocarditis: A Cardiovascular Magnetic Resonance Study

Monday, Nov. 27 11:50AM - 12:00PM Room: S502AB

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PURPOSE

Cardiac magnetic resonance (CMR) can detect inflammatory and functional myocardial alterations in patients suspected of having acute myocarditis. There is limited information regarding the degree of right ventricular involvement and the impact on right ventricular function over the course of the disease.

METHOD AND MATERIALS

69 patients with myocarditis underwent CMR during the acute stage of the disease (baseline) and after a mean 92.5 ± 50.4 days follow-up. The CMR protocol allowed for the assessment of standard Lake Louise criteria (T2 SI ratio, early gadolinium enhancement ratio, late gadolinium enhancement) and parameters of right and left ventricular function. Logistic regression analysis was used to find predictors of functional recovery upon follow-up.

RESULTS

All inflammatory parameters showed a considerable decrease over the course of the disease ($P>0.001$ for all parameters). Left (LV) and right ventricular (RV) function were significantly improved on follow-up CMR (LV function: 53.6 ± 12.8% vs. 61.3 ± 9.5%; $P<0.001$, RV function: 54.1 ± 10.0% vs. 59.4 ± 6.3%; $P<0.001$). On initial CMR, RV function was significantly correlated with the percentage of LV late gadolinium enhancement ($r= 0.255$; $P= 0.040$). 82.6% (57/69) of all patients had a recovery of myocardial function upon follow-up. Using logistic regression analysis, the presence of myocardial edema and baseline RV function were associated with functional recovery ($P<0.05$ respectively).

CONCLUSION

In this study, we found an association between a reduced RV function and the degree of myocardial inflammation. RV function improved during follow-up. These results indicate an inflammatory involvement of the right ventricle in acute myocarditis. It further appears that baseline RV function -like the presence of myocardial edema- seems to have a predictive value for functional recovery during the course of the disease.

CLINICAL RELEVANCE/APPLICATION

Right ventricular dysfunction can frequently be observed during the acute stage of myocarditis. RV functional impairment function might be useful as a new parameter for the prediction of functional recovery.

RSNA 2017 Explore. Invent. Transform.
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November 26 to December 1
McCormick Place, Chicago
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SSC02

Science Session with Keynote: Cardiac (Myocardial Ischemia, Viability, and Fractional Flow Reserve: CT)

Monday, Nov. 27 10:30AM - 12:00PM Room: S504AB

CA CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

Hajime Sakuma, MD, Tsu, Japan (*Moderator*) Research Grant, Fuji Pharma Co, Ltd; Research Grant, DAIICHI SANKYO Group; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Siemens AG; Research Grant, NIHON MEDIPHISICS; Speakers Bureau, Bayer AG
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Sub-Events

SSC02-01 Cardiac Keynote Speaker: Myocardial Perfusion and Delayed Enhancement with Dual-Source CT

Monday, Nov. 27 10:30AM - 10:50AM Room: S504AB

Participants
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SSC02-03 A Fast Functional CT Method for Assessing Myocardial Edema in Acute Myocardial Infarction

Monday, Nov. 27 10:50AM - 11:00AM Room: S504AB

Participants
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PURPOSE

We developed a fast functional CT technique for measuring extravascular contrast distribution volume (ECDV), which can be used to assess edema in acutely injured myocardium. This method relies on kinetic modeling of contrast retention in the myocardium after a bolus injection (BI). We validated this technique against a model-independent constant infusion (CI) method and cardiac magnetic resonance (CMR) T2-weighted (T2W) imaging in a pig model of reperfused acute myocardial infarction (AMI).

METHOD AND MATERIALS

CT and CMR studies were performed 12±3 days post ischemic insult in five pigs. In each CT study, 0.7 mL/kg of contrast was injected at 3-4 mL/s before dynamic contrast-enhanced (DCE) heart images were acquired with a 3-phase dynamic protocol on a GE CT750 HD scanner (<5 min). Next, the same dose of contrast was constantly infused for 1 hour, where 5 scans of the heart were taken both before and after CI of contrast. CMR T2W images were then acquired with a Siemens Biograph PET/MR scanner. From the BI study, DCE images were analyzed with a modified Johnson-Wilson-Lee model from which ECDV maps were generated. From the CI study, the pre- and post- images were subtracted to produce the difference images, which were then normalized to the arterial blood enhancement (in Hounsfield Unit) to estimate the partition coefficient (PC) in the myocardium. ECDV, PC and T2W signal intensities in the apical wall (injured) and mid-lateral wall (remote) of the left ventricle were compared.

RESULTS

Mean ECDV in the injured and remote segments were 0.46±0.18 ml/g and 0.22±0.10 ml/g respectively ($p<0.05$). The corresponding PC in the same segments were 0.59±0.15 and 0.29±0.05 respectively ($p<0.05$). CMR T2W images confirmed the injured apical segment was edematous as the signal intensity there was almost twice higher than that in remote (65.6±55.7 and 34.0±39.0 a.u., $p<0.05$).

CONCLUSION

After acute ischemic insult, interstitial and intracellular edema from enhanced cellular leakiness provide additional spaces for CT contrast to distribute. ECDV, which can be reliably assessed with a much faster BI protocol, is therefore a useful marker of myocardial edema in the acute phase post infarction.

CLINICAL RELEVANCE/APPLICATION

This method measures ECDV in conjunction to perfusion, which could be used to delineate the extent of myocardium at risk after a heart attack to inform revascularization.

SSC02-04 Whole-Heart Quantitative CT Myocardial Perfusion Imaging for Assessing Functionally Significant Coronary Artery Disease

Monday, Nov. 27 11:00AM - 11:10AM Room: S504AB

Participants
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PURPOSE

To determine the diagnostic accuracy of CT Perfusion for detecting functionally significant (FS) coronary artery disease (CAD) from whole-heart quantitative myocardial perfusion (MP) measurement

METHOD AND MATERIALS

Twenty-one symptomatic patients (age 59±9 yrs) with suspected or known CAD had the following tests within 6 weeks: CT and SPECT MP imaging at rest and after dipyridamole stress, coronary CT angiography (CCTA) and/or catheter-based coronary angiography (CAG). CCTA, CAG and SPECT MP imaging (with Tc99m-MIBI or 201-Thallium tracers) were performed using routine clinical protocols as required by the standard of care. In each CT MP study, 0.7 mgI/mL of iodinated contrast (Omnipaque350) was injected followed by saline flush before 12 cm of the heart was scanned over 20 mid-diastoles using a prospective ECG gating protocol on a GE Healthcare (GE) Revolution CT scanner. Dynamic contrast-enhanced heart images at 5 mm slice thickness were corrected for beam hardening and photon noise and residual motion using proprietary image reconstruction and non-rigid registration algorithms (GE) before they were reformatted into short-axis images from which rest and stress MP maps were generated using CT Perfusion (GE). Myocardial perfusion reserve (MPR) in each of the 17 short-axis segments were calculated as the ratio of stress to rest MP. A binomial logistic regression analysis was used to determine the diagnostic accuracy of CT-measured MPR for assessing FS CAD, which was defined as one of the following criteria: (1) >=70% narrowing in a coronary artery and/or >=50% narrowing in the left main artery; (2) 60-69% narrowing in a coronary artery with downstream ischemia assessed by the SPECT summed stress and difference scores; (3) previous episode of STEMI or NSTEMI. In all cases, CCTA was used for the anatomical evaluation of CAD only if CAG was not acquired.

RESULTS

Mean MPR in the FS CAD (n=25) and normal (n=38) coronary territories were 1.81±0.60 and 2.57±0.67 ($p<0.05$) respectively. The overall diagnostic accuracy of CT Perfusion for detecting FS CAD was 85.7% with 84.0% sensitivity and 86.8% specificity.

CONCLUSION

CT Perfusion showed an excellent diagnostic accuracy for detecting FS CAD as identified by combined CAG/CCTA and SPECT assessment.

CLINICAL RELEVANCE/APPLICATION

The high diagnostic accuracy of CT Perfusion for detecting high-grade coronary stenosis suggested that it is useful for risk stratification and management of CAD patients.

SSC02-05 Prognostic Value of Dynamic Stress CT Myocardial Perfusion in Patients with Suspected Coronary Artery Disease

Monday, Nov. 27 11:10AM - 11:20AM Room: S504AB

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PURPOSE

To evaluate the ability of dynamic stress computed tomography myocardial perfusion (CTP) to predict major adverse cardiac events (MACEs) in patients with suspected coronary artery disease (CAD).

METHOD AND MATERIALS

We included 193 consecutive patients without a history of myocardial infarction, revascularization, or cardiomyopathy who underwent coronary CT angiography (CTA) and CTP between March 2012 and February 2015. Significant coronary stenosis (>=50% luminal narrowing) was visually identified on CTA. Dynamic CTP images were obtained using adenosine triphosphate as a coronary vasodilator. The ratio of myocardial blood flow (MBF ratio) was calculated as the lowest MBF in the myocardial segments divided by the highest MBF showed by a remote myocardium. MACEs were defined as severe cardiac events (cardiac death, myocardial infarction, and unstable angina) and revascularization (>182 days after CTP).

RESULTS

Significant coronary stenosis was detected in 62 patients on CTA. Area under the receiver operating characteristic curve for the MBF ratio was 0.82 ($p < 0.001$) in the identification of all MACEs. The best cut-off of the MBF ratio was 0.68. The patients were divided into the four groups based on the results of CTA and CTP: CTA+/CTP+ (n = 39), CTA+/CTP- (n = 23), CTA-/CTP+ (n = 16), and CTA-/CTP- (n = 115). In Cox regression analysis, CTP maintained a >10-fold association with all MACEs when adjusted for CTA (adjusted hazard ratio, 13.4; $p = 0.014$). During a median follow-up of 29 months, 10 MACEs, including 3 severe cardiac events (1 myocardial infarction and 2 unstable angina) and 7 revascularizations, were observed. Kaplan-Meier curves demonstrated a significant difference in event-free survival between the CTA+/CTP+ group and the CTA+/CTP- group for severe cardiac events (annual event rate, 7.4% vs 0% respectively; log rank test, $p = 0.028$) and all MACEs (12% vs 1.2%; $p = 0.002$). No MACEs occurred in the CTA-/CTP+ group and the CTA-/CTP- group.

CONCLUSION

Among the patients with significant stenosis on CTA, patients with positive CTP had significantly worse prognosis than those with negative CTP for severe cardiac events as well as all MACEs.

CLINICAL RELEVANCE/APPLICATION

Dynamic stress CTP is useful for predicting cardiac events in patients with suspected CAD and provides additional prognostic information for patients with significant stenosis on CTA.

SSC02-06 Delayed Enhancement Dual Energy Computed Tomography for Detection of Myocardial Infarction in Stable Patients

Monday, Nov. 27 11:20AM - 11:30AM Room: S504AB

Participants
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PURPOSE

Aside from the acute myocardial infarction (MI) setting, delayed enhancement CT (CTDE) imaging suffers from a limited contrast tissue resolution compared to cardiac magnetic resonance (CMR). Accordingly, suboptimal results have been obtained for the assessment of chronic MI.We exploredthe ability of dual energy delayed enhancement CT (CTDE) to detect myocardial infarcts among stable patients.

METHOD AND MATERIALS

Our population comprised patients with documented previous myocardial infarction (n= 9) who underwent CTDE and DE-CMR), and patients with known or suspected coronary artery disease clinically referred for myocardial perfusion imaging by single-photon emission computed tomography (SPECT) (n= 25). Using a dual energy CT scanner, all patients (n=34) also underwent stress, rest, and CTDE.All CT scans were performed using a single-source dual energy CT scanner by rapid switching between low (80 kV) and high (140 kV) tube potentials, and prospective ECG gating. Images were obtained 7-10 minutes after contrast administration.

RESULTS

The mean age was 60.2±12.0 years, 26 (76 %) were male. A total of 12 (35%) patients showed evidence of MI at the reference study. CTDE had a sensitivity, specificity, positive predictive value, and negative predictive value for the detection of MI of 63% (95% CI 54-72%), 95% (95% CI 92-97%), 77% (95% CI 67-85%), and 90% (95% CI 87-93%), on a per segment basis; and of 85% (95% CI 66-96%), 97% (95% CI 91-100%), 92% (95% CI 74-99%), and 95% (95% CI 87-99%) on a per territory basis. The number of myocardial segments with DE was systematically lower with CTDE compared to the reference modality [median 2.5 (95% CI 1.65-4.0) segments vs. 4.0 (95% CI 0.0-6.0), Bland-Altman plot]. The mean signal density of MI at 40 keV was significantly higher than (at the same slice) normal myocardium (234±49.8 HU vs. 139±32.9 HU, $p<0.0001$).

CONCLUSION

In this study, CTDE using dual energy CT allowed an accurate detection of MI on per patient and per territory basis among stable patients, although it systematically underestimated the number of segments with DE.

CLINICAL RELEVANCE/APPLICATION

Dual energy delayed enhancement CT allowed an accurate detection of myocardial infarction

SSC02-07 Diagnostic Performance of a Fast, 3D Lattice Boltzmann-Based (LBM) Computational Fluid Dynamics (CFD) Method for Coronary Computed Tomography (CT)-Based Fractional Flow Reserve (FFR)

Monday, Nov. 27 11:30AM - 11:40AM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

FFR from CTA (CT-FFR) using CFD has excellent accuracy to detect lesion-specific ischemia (FFR<=0.8). The initial CT-FFR method (Heartflow FFRct) cannot be performed on-site due to lengthy CFD computations. Newer "on-site" methods compatible with clinical workflow (Siemens cFFR, Toshiba 4D CT-FFR) reduce computation time by simplifying the CFD from the 3-dimensional (3D) lumen to a 1- or 2-dimensional anatomic model. We developed a CT-FFR using the highly accurate and automatically parallelizable Lattice-Boltzmann CFD technique for the full 3D computation, and assessed its diagnostic accuracy to detect invasive FFR<=0.8

METHOD AND MATERIALS

64 consecutive patients at 3 hospitals with clinically-indicated CTA (64- to 320-row CT) and invasive FFR in an average of 40.6 days (interquartile range: 6-57) were retrospectively analyzed. Our LMB CT-FFR technique used an on-site tool to segment images and estimate patient-specific hyperemic conditions, and a commercial LBM platform (PowerFLOW, EXA Corporation) to seamlessly solve the CFD on 388 cores of a cloud computing service (ExaCLOUD). We report Pearson correlation and Bland-Altman limits of agreement with invasive FFR, and comparison of LBM CT-FFR and CTA % diameter stenosis (%DS) diagnostic accuracy to detect FFR<=0.8 using receiver operating characteristic curve areas (AUC)

RESULTS

LBM CT-FFR was successfully performed for 73 lesions in 60 patients; 4 patients were excluded (failure to segment). Mean invasive FFR was 0.81±0.1; 29 lesions (40%) had FFR<=0.8, and 19 (26%) had FFR 0.75 to 0.85. LBM CT-FFR analysis was 40±10 min/patient. Correlation (r=0.60), bias (0.009) and limits of agreement (-0.223 to 0.206) to invasive FFR were similar or better than reported for other CT-FFR technologies. ROC AUC to detect FFR<=0.8 was higher (p=0.002) for LBM CT-FFR (AUC=0.89, 95%CI: 0.79-0.99) than for CTA %DS (AUC=0.69, 95% CI: 0.58-0.79). Per-lesion specificity/sensitivity/diagnostic accuracy of LBM CT-FFR were 97.7%/79.3%/90.4%, respectively

CONCLUSION

Lattice-Boltzmann-based CT-FFR can be performed in <1hr while maintaining 3D CFD accuracy. The technique achieved 90% diagnostic accuracy to detect lesion-specific ischemia defined by invasive FFR<=0.8.

CLINICAL RELEVANCE/APPLICATION

Lattice-Boltzmann-based CT-FFR can be performed on site in <1hr, with 90% overall diagnostic accuracy to detect lesion-specific ischemia (invasive FFR<=0.8).

SSC02-08 3D Printed Patient-Specific Coronary Models for Testing CT-Derived FFR

Monday, Nov. 27 11:40AM - 11:50AM Room: S504AB

Participants
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PURPOSE

Non-invasive fractional flow reserve derived from coronary CT angiography (CT-derived FFR) is a tool based on computational fluid dynamics to non-invasively detect hemodynamically significant coronary lesions. We sought to develop patient-specific 3D printed coronary flow phantoms which can supplant or support expensive clinical trials for validation of CT-derived FFR technologies. These patient-specific benchtop hemodynamic simulations were validated against clinical catheter-based FFR and used to test one CT-derived FFR algorithm.

METHOD AND MATERIALS

Five patients underwent 320-detector row coronary CT angiography (CCTA) (Aquilion ONE, Toshiba) plus invasive coronary

Five patients underwent 320-detector row coronary CT angiography (CCTA) (Aquilion ONE, Toshiba) plus invasive coronary angiography and FFR within 90 days. The coronary lumen was segmented from CCTA using a 3D workstation (Vitrea, Vital Images) and used to 3D print (Connex3, Stratasys) multi-material models with hollow lumens for flow experiments. Printed models were connected to a benchtop system with physiologically accurate flow and pressure. Pressure sensors embedded in the printed models were used to measure benchtop FFR. Additionally, CCTA data of each patient was analyzed using a CT-derived FFR technique. Benchtop FFR was compared with catheter-based invasive FFR, and used to compare CT-derived FFR measurements. Correlation was estimated using Pearson method.

RESULTS

The mean invasive FFR was 0.84 (range: 0.76-0.90); one patient had hemodynamically significant disease (FFR<=0.8). Benchtop FFR measurements were within 13% (mean difference: 7%) of catheter-based FFR. Mean variance of CT-derived FFR from benchtop FFR was 8%. Benchtop FFR correlated with both invasive FFR (r=0.90) and CT-derived FFR (r=0.86).

CONCLUSION

Patient-specific coronary 3D printed benchtop models can replicate in vivo hyperemic blood flow conditions that match invasive FFR measurements. This novel benchtop system can supplant the cost and risk of initial validation and optimization of CT-derived FFR technologies.

CLINICAL RELEVANCE/APPLICATION

Patient-specific 3D printing of the coronary circulation can optimize application of CT-derived FFR toward alleviating the cost and risk of invasive coronary angiography to detect significant lesions.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Frank J. Rybicki III, MD, PhD - 2016 Honored Educator

SSC02-09 Four-Dimensional Image Tracking Method for Computed Tomography-Derived Fractional Flow Reserve: Influence of Different Cardiac Phase Durations on the Computed Tomography-Derived Fractional Flow Reserve Analysis

Monday, Nov. 27 11:50AM - 12:00PM Room: S504AB

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PURPOSE

In the new computed tomography-derived fractional flow reserve (CT-FFR) algorithm, four-dimensional CT (4D CT) image tracking is used to obtain an accurate estimation of fractional flow reserve (FFR) by analyzing four diastolic cardiac phase images between 70% and 99% of R-R interval. However, the CT image quality may be impaired by cardiac motion artifacts in the late diastolic phase. The purpose of this study was to investigate the diagnostic accuracy of the new CT-FFR methods by comparing CT-FFR by "entire diastolic phase" and "mid-diastolic phase" analysis with invasive FFR as a reference standard.

METHOD AND MATERIALS

We enrolled 10 patients including 33 vessels. Patients underwent coronary CT angiography (CTA) using a 320-row CT scanner (Aquilion One Genesis; Toshiba Medical Systems). The scan parameters for coronary CTA were as follows: detector collimation, 320 mm × 0.5 mm; tube current, 190-480 mA; tube voltage, 120 kV; and gantry rotation time, 275 ms. CT-FFR analysis was performed by an experienced radiological technologist using a dedicated workstation (Vitrea; Toshiba). Four CT images were reconstructed from the mid-diastolic phase (R-R, 70%-80%) and the entire diastolic phase (R-R, 70%-99%). CT-FFR values were compared with two methods at the position of 5.0 mm distal to the stenosis and at the position of the distal vessel with a diameter of 2.0 mm. The value of CT-FFR was compared with the minimum value of invasive FFR recorded for each segment of a coronary artery.

RESULTS

The mid-diastole CT-FFR value (0.87 ± 0.11) was significantly lower than the entire-diastole CT-FFR value (0.90 ± 0.08). However, when applying a CT-FFR threshold value of <0.8, there was no difference between mid-diastole and entire-diastole CT-FFR for the detection of ischemia-related lesions in all vessels except for one, which showed a value of 0.75 and 0.82 for mid-diastole and entire-diastole CT-FFR, respectively. Compared with invasive FFR, mid-diastole and entire-diastole CT-FFR detected all hemodynamically significant stenosis.

CONCLUSION

The CT-FFR provides a high diagnostic capability for the detection of hemodynamically significant stenosis, and compared with the "entire-diastole CT-FFR," the "mid-diastole CT-FFR" showed an equivalent diagnostic value.

CLINICAL RELEVANCE/APPLICATION

The "mid-diastole CT-FFR" has a comparable diagnostic capability with "entire-diastole CT-FFR," leading to a reduction of radiation dose in the CT-FFR analysis.

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SSC03

Chest (Lung Nodule)

Monday, Nov. 27 10:30AM - 12:00PM Room: S504CD

CH CT OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSC03-01 Automatic Detection of Malignant Pulmonary Nodules on Chest Radiographs Using a Deep Convolutional Neural Network: Detection Performance and Comparison with Human Experts

Monday, Nov. 27 10:30AM - 10:40AM Room: S504CD

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the performance of a deep learning-based automatic detection (DLAD) algorithm in detecting malignant pulmonary nodules on chest radiographs (CPAs) and its comparison with human experts.

METHOD AND MATERIALS

A DLAD algorithm was developed using a 25-layer deep convolutional network in a novel semi-supervised manner with 41,792 cases. For this observer performance test, 181 CPAs not used in the development of DLAD were included: 119 CPAs with 147 pathologically- or clinically-confirmed malignant lung nodules (mean size, 2.50 cm±1.60) and 62 normal CPAs. Reference for the nodules was established via CT taken within a week. Nineteen readers including 3 non-radiology physicians, 6 radiology residents, 5 board-certified radiologists, and 5 thoracic radiologists independently reviewed each CPA to detect lung nodules on a five-point confidence scale without DLAD (test 1). After test 1, each reader was allowed to change their decision by reviewing the results of test 1 and that of DLAD (test 2). The detection performances of DLAD, human experts (test 1), and human experts using DLAD (test 2) were evaluated and compared using jackknife free-response receiver operating characteristic (JAFROC) figure of merits (FOMs) on a per-nodule basis.

RESULTS

DLAD alone exhibited a FOM of 0.857, which was significantly higher than that of 16 of 19 readers (all *P*s <0.05). The mean FOM of the 19 readers using DLAD were significantly higher than that without DLAD (0.825 vs. 0.713, *P*=0.002). All readers showed improved detection performances for malignant pulmonary nodules using DLAD (mean FOM increase of 0.044 [range, 0.007-0.193]) with significant differences in 15 readers (*P*<0.05). On subgroup analysis, FOMs of the four reader groups (non-radiology physicians, radiology residents, board-certified radiologists, and thoracic radiologists) were 0.678, 0.784, 0.808, and 0.820, respectively, and their detection performances significantly improved with DLAD (0.814, 0.817, 0.827, 0.841; all *P*s <0.005).

CONCLUSION

DLAD showed better performance than most experts in detecting malignant pulmonary nodules on CPAs and enhanced the performance of human experts when used in conjunction.

CLINICAL RELEVANCE/APPLICATION

The excellent performance of DLAD demonstrates its great potential in changing our daily clinical practice; DLAD may provide

preliminary interpretation in pulmonary nodule detection on chest radiographs.

SSC03-02 Assessment of CT Texture Analysis as a Tool for Lung Nodule Follow-Up

Monday, Nov. 27 10:40AM - 10:50AM Room: S504CD

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PURPOSE

Lung nodule volumetry is currently the preferred method of following up small indeterminate lung nodules. This study assesses how CT texture analysis (CTTA) performs compared to volumetry in differentiating benign and malignant nodules.

METHOD AND MATERIALS

Data was collected for 143 patients with lung nodules (4-15mm) on an initial CT scan, with a follow-up CT 29 to 2747 days later. All scans had a slice thickness below 1.5mm. Nodules were delineated in 3D using a thresholded region with manual edits and the contour was propagated to a latter scan using deformable image registration. Definitive nodule diagnoses were established through histology, 2-year stability or malignant growth. Initially, the set was biased with respect to size (large nodules more likely to be cancer), so a subset of 113 patients (58 benign, 55 malignant) was selected such that size at presentation was uninformative (AUC 0.50-0.51). From each CT, a suite of classical texture features (Harlick, Gabor etc.) at various sizes/scales was extracted from isotropically-resampled volumes containing the contoured nodule. A derived feature vector was then created based on texture-feature changes between the first and second timepoints for each nodule, and volume doubling time (VDT) was calculated.

RESULTS

Area under the ROC curve (AUC) analysis showed that the VDT alone as an indicator of malignancy only performed at AUC=0.70 (95% CI=0.69-0.71). In contrast, the best difference-of-texture feature achieved AUC=0.81 (95% CI=0.80-0.82), with changes in size-linked texture features appearing more reliable than either absolute size at the second timepoint (AUC=0.75, 95% CI=0.74-0.76), or VTD. The mean of the top ten texture AUCs was above 0.76. This shows that quantitative texture measures extracted more information from the CT than size or VDT, and that this information is beneficial in malignancy prediction.

CONCLUSION

Our results indicate that changes in quantified texture around lung nodules and their surrounding microenvironment may be a more accurate tool for stratifying malignant lung nodules than VDT alone.

CLINICAL RELEVANCE/APPLICATION

Quantitative texture measures may be a useful adjunct in the follow-up of indeterminate lung nodules.

SSC03-03 Deep Learning-based Automatic Detection Algorithm for the Detection of Malignant Pulmonary Nodules on Chest Radiographs

Monday, Nov. 27 10:50AM - 11:00AM Room: S504CD

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PURPOSE

We developed a deep learning-based automatic detection (DLAD) algorithm for the detection of malignant pulmonary nodules on chest radiographs, and evaluated its diagnostic performance and nodule detection performance using large-scale chest radiograph (CR) data.

METHOD AND MATERIALS

A total of 44,087 CRs comprised of 9,269 abnormal and 34,818 normal CRs were collected. Abnormal CRs were pathologically or

clinically diagnosed as having malignant pulmonary nodules in 3,892 individuals (M:F=2,244:1,648; mean age, 63.6 years). Normal CRs were from 30,784 individuals (M:F=16,886:13,798; mean age, 51.3 years). We randomly split the datasets into a training set (33,467 normal and 8,625 abnormal CRs), a validation set (675 normal and 322 abnormal CRs) and a test set (675 normal and 322 abnormal CRs). There were no overlaps among these three datasets. We designed a deep convolutional network with 25 layers and 8 residual connections, and trained this network using a novel semi-supervised learning approach that partially utilized the location of the lesions, i.e., 6 thoracic radiologists manually marked the location of the abnormal lesions (3,213 CRs) in the abnormal CRs of the training set. The same radiologists also tagged the locations of all abnormal CRs in the validation and test sets to evaluate the localization performance of the DLAD algorithm. We then quantitatively verified the performances of DLAD by analyzing receiver-operating characteristics (ROC) curves for classification performance and localization average precision (AP) for detection performance.

RESULTS

In the validation dataset, DLAD showed an area under the ROC curve (AUC) of 0.9793, with an accuracy, sensitivity, and specificity of 93.83%, 85.54% and 98%, respectively. DLAD achieved 0.9257 for localization AP. In the test dataset, the AUC of DLAD was 0.9777 (accuracy, 93.53%; sensitivity, 86.2%; specificity, 96.15%). Localization AP was 0.862.

CONCLUSION

The DLAD algorithm demonstrated high diagnostic performance in differentiating malignant nodules from normal CR findings. DLAD also showed promising results in automatically detecting the location of nodules.

CLINICAL RELEVANCE/APPLICATION

As a second reader, DLAD has great potential to improve radiologists' detection performance and efficacy of malignant pulmonary nodules on chest radiographs.

SSC03-04 Computer-Aided Detection of Pulmonary Nodules on Chest Radiographs Using Deep Learning

Monday, Nov. 27 11:00AM - 11:10AM Room: S504CD

Awards
Student Travel Stipend Award

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PURPOSE

The chest x-ray is the most commonly performed radiology study, yet interpretation can be challenging. Deep learning systems for computer-aided detection (CAD) hold great potential but have been limited by the need for large numbers of radiologist-annotated radiographs. Other authors have described some success with report classification or manual annotation based CAD systems.We aimed to develop a novel nodule-detection CAD system, combining manually annotated images with 750,000 reported radiographs.

METHOD AND MATERIALS

We investigated image- and nodule-based metrics to compare our CAD system to alternatives. An ethics committee waiver of consent was granted.With natural language processing we analyzed free-text reports to generate labels, indicating which of our 750,000 radiographs contain a nodule or other abnormality. For 1,237 images, we provided radiologist-annotated boxes around 1,861 nodules. We proposed a CAD system using convolutional neural networks trained using hybrid loss on class labels and nodule annotations. The system can predict if there is a nodule and its location.For image-based classification, a test set of 7,850 images, 1,864 containing nodules, was used to assess the CAD system in predicting presence of a nodule. For nodule-based classification a test set of 575 previously unseen radiographs containing 787 nodules was used to investigate co-localization whilst penalizing false positives. For both, we applied other leading methodologies to our test dataset for comparison.

RESULTS

Image-based classification yielded an Accuracy of 0.76 and F1 of 0.67 (cf. 0.64 & 0.55 for annotation-based, and 0.72 & 0.62 for report-based CAD systems, respectively).Nodule-based metrics showed Recall 0.65, Precision 0.15, with 43% overlap between manual and CAD bounding boxes (cf. 0.37, 0.28, 30% for annotation-based, and 0.34, 0.10, 17% for report-based CAD systems).

CONCLUSION

Our study demonstrates improved nodule detection and localization from combining manual annotations with 'big data' from 750,000 films.With further work, CAD may act as a 'second reader' for chest radiographs, increasing sensitivity in nodule detection without compromising specificity.

CLINICAL RELEVANCE/APPLICATION

Computer-aided detection systems learning from 'big data' can help detect nodules on chest radiographs with potential to act as a cost-effective 'second reader' across healthcare systems worldwide.

SSC03-05 QIBA Challenge: Establishing Conformance of Segmentation Algorithms for Quantitative CT Volumetry

Monday, Nov. 27 11:10AM - 11:20AM Room: S504CD

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PURPOSE

To conduct a public Challenge through Quantitative Imaging Biomarker Alliance (QIBA) to assess the conformance of segmentation algorithms for CT volumetry and to establish interchangeability between real and simulated lesions.

METHOD AND MATERIALS

Simulated lung lesion models (based on pathologically confirmed malignant tumors) were virtually inserted into (a) 3 phantom datasets using validated projection and image-domain insertion programs, and (b) 30 clinical chest CT cases containing real lesions "hybrid datasets". The study was designed as a public Challenge to academic researchers and commercial software developers to apply their volume estimation algorithms on simulated and corresponding real lung lesions. Equivalence between real and simulated lesions was analyzed in terms of bias and repeatability coefficient (RC) (phantom only), and algorithm reproducibility (variance between measurements by different algorithms on the same lesion). Comparisons were made relative to insertion method, participant, and lesions (shape, size, location).

RESULTS

8 and 16 groups (industry/academic) participated in the phantom and hybrid sections of the Challenge, respectively. Either fully or semi-automated segmentation algorithms were used. Percent bias and repeatability coefficient based on the defined QIBA compliance criteria showed that 3 of 8 groups were fully compliant with the profile, and one close non-compliance. For compliant groups, %bias (95% confidence intervals) was -0.43% (±5.6%) for real and -0.34 to -2.2% (±5.8%) for simulated lesions; while RC was 13% for real and 2 to 13% for simulated lesions.

CONCLUSION

Hybrid datasets can overcome phantom lack of realism and patient lack of ground truth limitations. Our results indicate that simulated and real lesions are generally comparable but exhibit differences for certain algorithms. This shows simulated lesions inserted into clinical cases can be used in the assessment of quantitative volumetry methods.

CLINICAL RELEVANCE/APPLICATION

Hybrid datasets help us better assess the performance of lesion segmentation algorithms for QIBA Profile conformance. This enables translation of precision medicine in the context of quantitative CT.

SSC03-06 Pulmonary Hamartomas: Safely Increasing the Rate of CT Diagnosis

Monday, Nov. 27 11:20AM - 11:30AM Room: S504CD

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PURPOSE

For decades, the CT diagnosis of pulmonary hamartoma (PH) has been based on the presence of popcorn calcifications or fat (-40 to -120 HU) limited to a smooth <2.5cm pulmonary nodule. These rigid criteria were selected to avoid classifying necrotic neoplasms as benign. A minority of the PH fulfill these criteria which results in unnecessary surgical resections. The aim of our study was to assess the spectrum of HU distribution in PH and whether the adoption of a wider threshold for fat content can safely be implemented for non invasively diagnosing PH without misinterpreting malignant lesions as benign.

METHOD AND MATERIALS

We retrospectively assessed the CT scans of consecutive histologically confirmed: PH (histPH), pulmonary metastases and primary lung cancers as well as PH diagnosed by CT (CTPH). Their size, volume, average, minimum and maximal HU were assessed using an ROI of at least 8 pixels, placed in the lowest attenuation region of the nodule.

RESULTS

There were 52 histPH, 41 metastases, 49 primary lung cancers, and 34 CTPH. PH average size and volume were 14.5mm and 2270.2mm 3 and that of malignancies 26.5mm and 22,031mm 3. Popcorn calcifications were seen in 2 (4%) histPH, 11 (32%) CTPH

and non of the malignant lesions. The average HU for histPH, CTPH, metastases, and primary lung cancers were: 3.99, -10.97, 25.53, 38.61 respectively. Of the malignant lesions, only 4 had an average of <0 HU and comprised of metastses of sarcoma (n=1), colon (n=1), mature cystic teratoma (n=1) and ovary (n=1). Minimum pixel HU value of <0 were seen in 28 (31.1%) of malignant nodules with the lowest minimal pixel value of -42 as compared to 44 (84.6%) of the histPH and 33 (97%) of the CTPH with a minimal pixel value of -168 HU. By raising the average HU threshold value for diagnosing PH from -40 to -20, the sensitivity for diagnosing PH rises from 9.3% to 18.6% while the positive predictive value and the specificity remain 100%.

CONCLUSION

By increasing the threshold for identification of fat in PH to -20 unnecessary surgical intervention may be prevented without misdiagnosing cancer as benign.

CLINICAL RELEVANCE/APPLICATION

By increasing the threshold for fat identification, a greater number of PH will be safely identified and unnecessary surgery avoided.

SSC03-07 Computer-Aided Detection (CAD) Of Pulmonary Nodules on Computed Tomography (CT) With AIDR3D in Vivo-Result: Comparison between Ultra-Low-Dose CT (ULDCT) Equivalent Dose to Chest X-Ray and Low-Dose CT (LDCT)

Monday, Nov. 27 11:30AM - 11:40AM Room: S504CD

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PURPOSE

To determine the beneficial effect of computer-aided detection (CAD) for pulmonary solid and sub-solid nodules in ultra-low-dose CT with AIDR 3D (ULDCT) and low dose CT with AIDR 3D (LDCT).

METHOD AND MATERIALS

This was part of the ACTIve Study, a multi-center research project in Japan. The Institutional Review Board of each institution approved this study, and written informed consent was obtained. In a single visit, 68 subjects underwent chest CT (64-row helical mode) using identical 320-row scanners with different tube currents: 240,120 and 20 mA (2.51, 1.26 and 0.21mSv, respectively). Standard of reference (SOR) was established based on consensus reading of CT images at 240mA by two radiologists. CAD was performed in ULDCT (20mA) and LDCT (120mA) with lung reconstruction kernels. Another 2 observers independently assessed lung nodule presence on both methods. In total and 4 subgroups classified according to the combination of nodular size (<5, >5mm) and characters (solid, sub-solid), nodule detection rate (NDR) for both CAD and 2 observers with CAD was compared between both methods with Fisher's exact probability test, and NDR without CAD and that with were compared with McNemar test for each observer. Scan-based false positive ratio by CAD (FPR) was compared with paired t-test between both methods.

RESULTS

For SOR, 123 solid and 100 sub-solid nodules were identified (mean diameter 6.0 ±4.1 mm, range 2-29 mm). NDR by CAD on ULDCT (28%) was similar to that on LDCT (30%) in total as well as the 4 subgroups ($p>0.05$). CAD led to a significant increase of NDR for 2 observers on both modalities for smaller solid nodules (<5mm) ($p<0.001$) and observer 1 on LDCT for larger solid nodules (>5mm) ($p=0.031$). For larger nodules, NDR for 2 observers with CAD on ULDCT (92% for solid, 77% for sub-solid) was comparable to that on LDCT (95% for solid, 86% for sub-solid) ($p>0.05$). FPR on LDCT (2.5±4.1) was similar to that on ULDCT (2.4±2.2).

CONCLUSION

ULDCT showed comparable NDR for larger nodules to LDCT regardless of CAD application. In contrast, adding CAD in ULDCT improved NDR by observers for smaller solid nodules, although similarity in NDR to LDCT was not achieved.

CLINICAL RELEVANCE/APPLICATION

ULDCT could be useful for larger lung nodule detection irrespective of nodular characters and provide improved detection sensitivity of radiologists by CAD for smaller lung solid nodules

SSC03-08 Lung Nodule Volumetry: Variability at Multiphase Cardiac CT

Monday, Nov. 27 11:40AM - 11:50AM Room: S504CD

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PURPOSE

The purpose of the study was to determine the intra-scan variability of volumetric measurements of solid pulmonary nodules.

METHOD AND MATERIALS

In this retrospective study, 827 consecutive patients that underwent cardiac multi-phase CT scan were evaluated. All the CT exams were performed on a 256-row CT scanner (SIEMENS Somaton Definition Flash) using 0.6mm slice thickness and soft kernel. The image reconstructions were done using 10 phases in 10% of each RR interval. The images were evaluated in the axial plane to identify the lung nodule and after the semi-automatic tool for lung lesions / volumetry was applied. The volume of the nodule was determined two times according with two different phases of the scan for each patient.

RESULTS

For statistical analysis 66 pulmonary nodules with medium volume of 8mm were included. The mean nodule volumetric difference was 513mm3 or 21.6%. Confidence interval of difference observed on measurements taken on different cardiac phases: Percentile 5. 15mm3 or 0.00%; Percentile 50. 62mm3 or 14%, and Percentile 95. 1696mm2 or 58%. The volume measurements showed significant variability for any one given nodule during a single multi-phase scan ($p<0.05$). There was no correlation between the volume measurement of the nodule and the difference between the volume measurements.

CONCLUSION

There is significant cardiac phase variability in lung nodule volume measurement.

CLINICAL RELEVANCE/APPLICATION

Lung nodule measurements are important in identifying potential early malignant transformation and relies on identifying a significant increase in size (25%) and change in character between serial scans.In recent years many limiting factors to the measurements' accuracy have been identified, such as nodule size, location, morphology, inspiratory effort and others such as the technical parameters of the scan.Our purpose is to determine the importance of the hemodynamic factors in the lung nodule volumetry, measuring the variation and reliability of semiautomated lung nodule volumetric measurements during the same CT acquisition and in different cardiac phases.

SSC03-09 Pulmonary Nodules in Melanoma Patients: How Long Do We Need to Follow Them to Determine if They Are Benign or Metastatic?

Monday, Nov. 27 11:50AM - 12:00PM Room: S504CD

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PURPOSE

This study aims to determine what timeline should be utilized to follow pulmonary nodules in melanoma patients to confirm metastatic or benign origin and to delineate features that favor metastatic versus benign etiology.

METHOD AND MATERIALS

588 patients had surgery for primary melanoma between 2012-15 in our tertiary care centre. Out of these, 148 patients had baseline chest CT and at least one followup (FU) CT and were included in the study. Patients with definitely benign nodules, metastases and other non-melanoma malignancies were excluded. Nodules were volumetrically measured on FU CTs and a cut-off of 15% difference in volume was considered as significant change. Distance from pleura, peripheral versus central and perifissural location, irregularity, solid versus groundglass density were evaluated. Nodules were considered metastases if they increased in size between two FU CTs or if increase was accompanied by multiple new lung nodules or extrapulmonary metastases.

RESULTS

On baseline CT, 70 patients (A) had at least one indeterminate pulmonary nodule (IPN) and 78 (B) had none. In group A all patients had 243 IPN (0.0236 cm3) and only 1 nodule increased 405% in volume in 5 months and was proven metastatic. Out of 243 IPN, 215 were peripheral, 40 perifissural, 218 solid, 25 groundglass, 4 had irregular margins. 18 nodules increased 50% in volume in the first 3-month CT and either resolved or decreased in another 3 months. During FU, overall, 28 patients developed 33 new nodules (0.0814 cm3) out of whom 24 (86%) were metastases. In 4 patients, nodules resolved or decreased in 5.5 months and were presumed benign. All metastases (33) were solid and 4 were perifissural. Median volume increase between 2 CTs (median 3 months) was 260% ($p <0.001$). All but one metastases had smooth margins.

CONCLUSION

IPN on baseline CT are most likely benign and monitoring up to 6 months can confirm it. Newly developed nodules have a high possibility of being metastatic and FU in 3 months can confirm it if needed. Volume increase is significantly lower in benign than metastatic nodules. Perifissural location of new nodules does not exclude metastatic origin, however groundglass and irregular

margin most likely does.

CLINICAL RELEVANCE/APPLICATION

IPN on baseline CT require monitoring up to 6 months to confirm benign origin. Newly developed nodules have a high risk of being metastatic and follow up in 3 months will confirm increase in size.

SSC04

Gastrointestinal (Rectal Cancer)

Monday, Nov. 27 10:30AM - 12:00PM Room: E353A

GI MR OI BQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSC04-01 Comparison in Prognosis of Patients with Rectal Cancer between Low- and High-Risk Group Defined by Magnetic Resonance Imaging (MRI)

Monday, Nov. 27 10:30AM - 10:40AM Room: E353A

Participants
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PURPOSE

To compare the prognosis of patients with rectal cancer between low- and high-risk group detected by MRI, who were treated by total mesorectal excision (TME) surgery and selective adjuvant chemoradiotherapy

METHOD AND MATERIALS

Patients with pathology-proven rectal adenocarcinoma and received TME surgery between January 2006 and December 2014 were included in this retrospective study. Patients who were treated with neoadjuvant chemoradiotherapy, and had other malignancies or distant metastasis were excluded. All included patients had been followed-up until December 2016. The risk factors detected by MRI were defined as: extramural depth of tumor invasion larger than 5mm for mid and upper tumor, intersphincteric space invasion for low tumor, extramural venous invasion (EMVI), circumferential resection margin (CRM) involvement. Patients were divided into low- and high-risk group based on the presence of risk factors. Kaplan-Meier method was used to compare the local overall survival (OS), disease-free survival (DFS), and local recurrence (LR) between two groups, and analyze the univariate influence of risk factors of OS, DFS and LR. A Cox proportional hazards regression model was constructed to figure out independent risk factors of OS, DFS and LR.

RESULTS

Sixty-five patients (35.1%) of whole cohort (185) were divided into low-risk group and 120 (64.9%) were divided into high-risk group. Significant difference was demonstrated between low- and high- risk group shown as 3-year actuarial OS (100% vs.87.8%), DFS (92.3% vs.55.7%) and LR (3.1% vs.10.4%). Compared with mrT and mrN, CRM was identified as the independent risk factor of OS (HR 4.70, 95% confidence interval (CI) 1.25-17.66), DFS (HR 2.44, 95%CI 1.24-4.81) and LR (HR 3.92, 95%CI 1.07-14.41) by using the Cox proportional hazards regression analysis. Moreover, EMVI was identified as the independent risk factor of DFS (HR 2.46, 95%CI 1.28-4.73).

CONCLUSION

For patients with rectal cancer, CRM and EMVI status preoperatively assessed by MRI are the most important factors in predicting local recurrence and long-term survival.

CLINICAL RELEVANCE/APPLICATION

Estimating the presence of risk factors by MRI preoperatively can help predict prognosis and make decision of whether patients need to receive neoadjuvant therapy before TME surgery.

SSC04-02 Comparison of Reduced Field-of-View Diffusion Weighted Imaging (DWI) and Conventional DWI Techniques in Assessment of Rectal Carcinoma at 3.0 T: Image Quality and Histological T Staging

Monday, Nov. 27 10:40AM - 10:50AM Room: E353A

Participants

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PURPOSE

To assess the image quality (IQ) and histological T staging of rectal cancer by comparison of reduced field-of-view (FOV) and full FOV DWI sequences at 3T.

METHOD AND MATERIALS

Eighty-one patients with rectal cancer received MR scan of both rFOV DWI and fFOV DWI sequences. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were quantitatively evaluated using paired T test. Two radiologists independently assessed the subjective IQ parameters including image sharpness, distortion, artifacts, lesion conspicuity and overall subjective IQ of both DWI sequences. Wilcoxon signed rank test was used to compare subjective IQ scores and tumor ADCs between DWI sequences. Mean tumor ADCs between DWI sequences were compared in relation to corresponding T staging of rectal cancer by utility of the spearman rank correlation analysis test.

RESULTS

CNR was significantly higher in rFOV DWI than in fFOV DWI (7.15±2.77 vs. 5.39±2.08, P<0.001). SNR was significantly higher in rFOV DWI than in fFOV DWI (44.17±11.01 vs. 34.76±13.30, P<0.001). The subjective IQ parameters of rFOV DWI sequence were rated superior to that of fFOV DWI sequence by both readers (P<0.001). There was no significant difference between mean tumor ADC values of rFOV and fFOV DWI sequences (0.991±0.121 vs. 0.100±0.126×10-3mm2/s, P=0.617). Apart from T1 stage, T staging of rectal cancer was correlated inversely with ADC values of rFOV DWI (r= -0.688, P<0.001) and fFOV DWI sequences (r= -0.641, P<0.001).

CONCLUSION

rFOV DWI sequence provided significantly higher image quality and lesion conspicuity than fFOV DWI sequence. Besides, both DWI sequences can be used for evaluation of histological T staging of rectal cancer.

CLINICAL RELEVANCE/APPLICATION

Image quality can be improved by utility of rFOV DWI sequence and is recommended as part of MR study for rectal cancer before total mesorectal excision(TME) surgery

SSC04-03 Colorectal Carcinoma: Ex Vivo Evaluation using q-Space Imaging and its Correlation with Histopathologic Findings

Monday, Nov. 27 10:50AM - 11:00AM Room: E353A

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PURPOSE

To determine the feasibility of ex vivo q-space imaging (QSI) as a method of evaluating the histologic grades of colorectal carcinomas and lymph node metastasis by colorectal carcinomas.

METHOD AND MATERIALS

Twenty colorectal specimens each containing a carcinoma and their resected lymph nodes were imaged with a 3-T MR imaging system equipped with a 4-channel phased-array surface coil. QSI data were obtained by using a spin echo-based single-shot echo-planar imaging sequence: repetition time, 10000 ms; echo time, 216 or 210 ms; field of view, 113 mm x 73.45 mm; matrix, 120 x 78; section thickness, 4 mm without intersection gaps; eleven b values ranging from 0 to 9000 s/mm2; and motion-probing gradients perpendicular to the colorectal wall. Mean displacement (MDP; in μm), zero-displacement probability (ZDP; in arbitrary unit [a.u.]), and kurtosis (K; in a.u.) were calculated from the displacement distribution profiles, and apparent diffusion coefficient (ADC) was also calculated from two b values (b = 0 and 500 s/mm2). The MR images were then compared with the histopathologic findings as the reference standard.

RESULTS

In all 20 colorectal carcinomas, the MDP was calculated as 8.85 ± 0.36 μm, ZDP 82.4 ± 6.2 a.u., K 74.4 ± 3.0 a.u., and ADC 0.219 ± 0.041 x 10-3 mm2/s. With the histologic grades (well, moderately, and poorly differentiated) of the colorectal carcinomas, the MDP (r = -0.829; P < 0.001) showed a significant inverse correlation and the ZDP (r = 0.810; P < 0.001) and K (r = 0.848; P < 0.001) showed a significant positive correlation, while the ADC (r = 0.104; P = 0.673) showed no significant correlation. Between metastatic lymph nodes and nonmetastatic lymph nodes, the MDP (10.3 ± 1.2 vs. 19.0 ± 2.0 μm; P < 0.01), ZDP (53.6 ± 16.1 vs. 26.2 ± 2.0 a.u.; P < 0.01), and K (61.0 ± 10.9 vs. 25.3 ± 2.7 a.u.; P < 0.01) showed significant differences, while the ADC (1.02 ± 0.38 vs. 1.39 ± 0.09 x 10-3 mm2/s; P = 0.095) showed no significant differences.

CONCLUSION

QSI provides useful diagnostic information for evaluating the histologic grades of colorectal carcinomas and lymph node metastasis by colorectal carcinomas.

CLINICAL RELEVANCE/APPLICATION

By using QSI for patients with colorectal carcinoma, we may have an effective tool to noninvasively diagnose the histologic grades of colorectal carcinomas and lymph node metastasis by colorectal carcinomas.

SSC04-04 Long-Term Follow-Up with MRI during a "Watch-And-Wait" Approach in Clinical Complete Responders after Chemoradiotherapy

Monday, Nov. 27 11:00AM - 11:10AM Room: E353A

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PURPOSE

A 'watch-and-wait' approach is emerging as an alternative to resection in rectal cancer patients with a clinical complete response (CR) after CRT. Follow-up consists of clinical examination, endoscopy and MRI. Limited data exists on what to expect on MRI during follow-up. Aim was to evaluate the morphology of the rectal wall in patients in the watch-and-wait programme and study its evolution during follow-up for watch-and-wait these patients.

METHOD AND MATERIALS

140 patients with a sustained complete response (i.e. no evidence of recurrence on sequential imaging and endoscopy±biopsy examinations) were analysed during follow up within the scope of a 'watch-and-wait' protocol. Patients underwent MRI (and clinical examination and endoscopy) 3-monthly in the first year and 6-monthly during the 2nd to 5th year. Two readers in consensus analysed the rectal wall morphology on the initial post-CRT scan and studied the evolution in morphology on the various sequential follow-up MRIs.

RESULTS

Median follow-up time was 18 months (range 6-82). A total of 801 MRIs were analysed (median 5, range 2-13 per patient). In 9% of patients the rectal wall completely normalised post-CRT. The other 91% showed a fibrotic remnant (64% minimal fibrosis limited to the bowel wall; 21% thick/mass-like fibrosis and 6% irregular/spicular fibrosis). In 92% the rectal wall morphology remained unchanged during long-term follow-up, in 4% initial fibrosis later developed into a normalised wall, in 4% the fibrosis slightly thickened (without evidence of recurrence).

CONCLUSION

In the vast majority of patients with a complete response residual fibrosis is present post-CRT, which remains unchanged during long-term follow-up in almost all patients. A completely normalised wall is observed in approximately 1 in 10 complete responders. These findings may serve as a reference and provide teaching for radiologists involved in the clinical follow-up of patients selected to undergo a watch-and-wait policy.

CLINICAL RELEVANCE/APPLICATION

Knowledge of the evolution of the rectal wall is crucial to allow for safe use of a watch-and-wait approach in complete responders after CRT for rectal cancer.

SSC04-05 Use of Restaging Abdominopelvic CT after Neoadjuvant Chemoradiation Therapy in Patients with Nonmetastatic Locally Advanced Rectal Cancer

Monday, Nov. 27 11:10AM - 11:20AM Room: E353A

Participants
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PURPOSE

Neoadjuvant chemoradiation therapy (CRT) before surgery is current standard for locally advanced rectal cancer without distant metastasis, but it delays surgery for several months. We investigated if restaging abdominopelvic CT before surgery after CRT is beneficial given the time lag from the initial diagnosis.

METHOD AND MATERIALS

472 consecutive patients (M:F, 308:164; 62.2±11.8 years) who had newly diagnosed rectal cancer (T3 or N+ as assessed with MRI), no distant metastasis or any lesions that were not cleared of metastasis as evaluated with both CT and PET/CT, and no previous (during past 5 years) or concomitant cancers, underwent long-course CRT. Patients were reevaluated 4-6 weeks after CRT with rectal MRI and restaging abdominopelvic CT (n=231) or with rectal MRI alone (n=218). 23 patients dropped out. Diagnostic yield of the restaging CT for abdominopelvic metastasis was determined. The rate of overlooked abdominopelvic metastasis, defined as lesions that were unexpectedly found during rectal cancer surgery or developed early (within 6 months) after the surgery or CRT (for 8 patients followed without surgery), and the outcome of the overlooked lesions were compared between the two patient groups. Abdominopelvic progression-free survival (PFS) was compared between the two groups.

RESULTS

Diagnostic yield of restating CT was 2.2% (5/231), all of which were resected with curative intent. Restaging CT created false positives in three patients, causing unnecessary hepatic resection (n=1), RFA (n=1), and follow-up liver MRI (n=1). Restaging CT group had seven patients (3%) with overlooked abdominopelvic metastasis; four patients found during the surgery, three of whom could be operated with curative intent, and three patients as early postsurgical metastasis, one of whom was amenable to curative-intent treatment. The no CT group had seven patients (3.2%) with overlooked metastasis; all as early postsurgical metastasis, three of whom were amenable to curative-intent treatment. These rates did not significantly differ (P=1). Abdominopelvic PFS did not significantly differ between the two groups (P=.426).

CONCLUSION

Restaging abdominopelvic CT after CRT for locally advanced rectal cancer does not have a clear benefit due to its low yield, insufficient exclusion of metastasis, and unignorable risk of false-positives.

CLINICAL RELEVANCE/APPLICATION

This study recommends against restaging abdominopelvic CT after CRT for rectal cancer.

SSC04-06 PET/MRI in Patients with Pelvic Recurrence of Rectal Cancer: Technical Feasibility and First Clinical Experiences

Monday, Nov. 27 11:20AM - 11:30AM Room: E353A

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PURPOSE

Accurate diagnosis of pelvic recurrence of rectal cancer is crucial in determining further treatment, especially prior to surgical resection. So far, PET/MRI has not been widely used in this setting. The purpose of this study was to determine the value of PET/MRI in the pre-therapeutic staging and management of patients with pelvic recurrence of rectal cancer.

METHOD AND MATERIALS

Out of 57 patients with a history of rectal cancer who received PET/MRI between June 2011 and July 2016 at our institution, 34 patients were retrospectively enrolled in the study. 23 patients were excluded because they were lost to follow-up. One patient received two PET/MRIs, thus a total number of 35 examinations was included. Pelvic recurrence was confirmed either with histology (biopsy n=5, surgery n=21) or clinical and imaging follow-up (>6 months). Two blinded readers (1 radiologist, 1 nuclear medicine physician) interpreted the images in consensus. Pelvic lesions were assessed regarding FDG-uptake, morphology, contrast enhancement and diffusion restriction. Sensitivity, specificity, positive and negative predictive value as well as accuracy of PET/MRI were determined.

RESULTS

In 35 PET/MRIs 26 pelvic lesions were identified, out of which 25 were deemed suspicious for pelvic tumor recurrence. One lesion was thought to be a vesicovaginal fistula. 24 of the 25 lesions were confirmed as malignant. One patient was resected and had histologically proven pelvic recurrence without suspicious findings on PET/MRI. Changes in management due to PET/MRI findings were implemented in 2 patients (metastasis sacral nerve=1, penile metastasis=1), 83% of resected patients had histologically negative resection margins (R0). The sensitivity of PET/MRI in detecting recurrence was 96%, specificity 92%, positive/negative predictive value and accuracy were 96%, 92% and 95%, respectively.

CONCLUSION

PET/MRI demonstrates high sensitivity and specificity in the preoperative diagnosis and staging of pelvic recurrence in patients with rectal cancer.

CLINICAL RELEVANCE/APPLICATION

PET/MRI is a valuable tool in the preoperative diagnosis and staging of pelvic recurrence in patients with rectal cancer, aiding in achieving high rates of R0-resection.

SSC04-07 Interobserver Reproducibility in Assessing the Response after Neoadjuvant Chemoradiation Therapy for Locally Advanced Rectal Cancer Using Magnetic Resonance Tumor Regression Grade (mrTRG)

Monday, Nov. 27 11:30AM - 11:40AM Room: E353A

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PURPOSE

Methods to assess the response after neoadjuvant chemoradiation therapy (CRT) for locally advanced rectal cancer on post-CRT MRI have been proposed, of which magnetic resonance tumor regression grade (mrTRG) is seemingly most recognized. However, interobserver reproducibility of mrTRG has hardly been evaluated outside those who developed the mrTRG system. This study is to assess the interreader reproducibility of mrTRG externally.

METHOD AND MATERIALS

50 pairs of pre- and post-CRT (obtained 4-6 weeks after the finish of CRT) rectal MRI sets obtained in 50 patients (M:F, 36:14; 65.5±12.4 years), who were randomly chosen from a consecutive cohort of 439 patients who underwent long-course CRT for a newly diagnosed locally advanced rectal cancer (T3 or N+ stage as seen on pre-CRT MRI, no distant metastasis, and no other previous or concomitant cancers), were included. Before the study, three abdominal radiologists experienced with rectal MRI went through an educational session consisting of a review of 50 training cases collected outside the study cohort and reading of relevant articles. The three readers assessed the CRT response for this study using mrTRG (1 to 5) independently blinded to any other information than the history of CRT. We analyzed interreader reproducibility regarding the description of individual mrTRG (1 to 5) as well as regarding the binary interpretation of mrTRG1 and 2 (i.e., good response) vs. 3-5, using weighted kappa with linear weights and the conventional kappa, respectively. For mrTRG1 and 2 vs. 3-5, the proportional agreement was also obtained.

RESULTS

According to the consensus interpretation among the three readers, the mrTRG distribution in the study patients was 14% mrTRG1 (n=7), 26% mrTRG2 (n=13), 32% mrTRG3 (n=16), 28% mrTRG4 (n=14), and 0% mrTRG5. The weighted kappa for describing the individual mrTRG (1 to 5) was 0.62 overall and 0.60 to 0.62 for individual reader pairs. The kappa for mrTRG1 and 2 vs. 3-5 was 0.65 overall and 0.57 to 0.72 for individual reader pairs. The proportional agreement in interpreting mrTRG1 and 2 vs. 3-5 was 83% overall and 80-86% for individual reader pairs.

CONCLUSION

mrTRG showed a substantial interobserver reproducibility, which further supports its implementation for use in clinical practice and trials.

CLINICAL RELEVANCE/APPLICATION

mrTRG could be used fairly reliably in clinical practice and trials to guide further treatment after neoadjuvant CRT for rectal cancer.

SSC04-08 Assessing FDG-PET/3-T MRI after Preoperative Chemoradiotherapy for Rectal Cancer

Monday, Nov. 27 11:40AM - 11:50AM Room: E353A

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PURPOSE

To assess the accuracy of pelvic 3-T MRI and combined FDG-PET/3-T MRI (PET/MRI) in predicting pathological tumor and node (ypTN) stages, and to compare the accuracy of whole-body PET/MRI with thoraco-abdominal CT (CT) in predicting metastases (ypM) stage.

METHOD AND MATERIALS

This prospective study concerned 17 patients (16 male) with locally advanced rectal cancer who underwent preoperative chemoradiotherapy, PET/MRI and CT for staging purposes. PET/MRI included T2 and diffusion weighted images. Total mesorectal excision was the treatment of choice for 13 patients; the remainders were MRI node negative and underwent transanal local excision with at least 1-year endoscopic and pelvic MRI follow-up. Concurrent distant metastases were confirmed by surgery/biopsy or followed up with CT. One radiologist assessed pelvic MRI and CT images. Another radiologist and a nuclear medicine physician jointly assessed PET/MRI findings. All three were blinded to all other imaging and pathology results.

RESULTS

ypT was T0 in 4 patients, T1 in 3, T2 in 1, T3 in 7, and T4 in 2. ypN was positive in 5/17 cases, and metastases were detected in 3/17 patients. MRI and PET/MRI findings for ypT were concordant and correct in 11/17 patients (64.7%), concordant and incorrect

in 2/17 (11.8%), and discordant in 4/17 (23.5%), PET/MRI staging being correct in 2 cases. As for ypN staging, MRI and PET/MRI were concordant and correct in 14/17 patients (82.3%) and discordant in 3/17 (17.7%), with PET/MRI staging predicting ypN status in 2 cases. Two patients with metastases were diagnosed correctly, while PET/MRI misdiagnosed one case of a small lung metastasis.

CONCLUSION

Integrated whole-body PET/MRI improves the accuracy of ypTN staging, but is less accurate than CT in ypM staging. Further studies are needed, including efforts to refine PET/MRI by using specific sequences for the lung and intravenous gadolinium, to examine the role of this technique in monitoring distal cancer spread. If successful, it would be possible to combine local and distant rectal cancer staging in a single examination.

CLINICAL RELEVANCE/APPLICATION

FDG-PET/3-T MRI can be a useful tool for the whole-body staging (TNM) of patients with advanced rectal cancer after chemoradiotherapy.

SSC04-09 Tumor Heterogeneity MRI Features Improve Machine Learning-Based Prognostication in Patients with Metastatic Colon Cancer

Monday, Nov. 27 11:50AM - 12:00PM Room: E353A

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PURPOSE

Intra-tumor heterogeneity has been previously shown to be an independent predictor of patient survival. The goal of this study is to use machine learning to assess the role of quantitative MRI-based measures of intra-tumor heterogeneity as predictors of survival in patients with metastatic colorectal cancer.

METHOD AND MATERIALS

In this IRB-approved retrospective study, we identified 52 patients with stage 4 colon cancer who underwent MRI from 2007-2013 for liver metastasis evaluation. Patient survival data was available for up to 95 months. Standard clinical and pathologic prognostic variables were extracted from the medical record. The largest metastatic hepatic lesion was identified on portal venous phase T1-weighted fat-suppressed post-contrast images and manually segmented. A heterogeneity phenotype vector was extracted from each lesion by using quantitative texture analysis as a measure of spatial heterogeneity. Univariate regression analysis was used to assess for independent contribution of 32 extracted texture features to survival prediction. A linear support vector machine (SVM) machine learning technique was applied to the extracted heterogeneity phenotype vector and to the standard prognostic clinical and pathologic variables. The classifiers were trained and tested using 10-fold cross validation to avoid overfitting. ROC analysis and the area under the curve (AUC) were used to assess classification performance. Delong's test was used to assess for differences between ROC curves.

RESULTS

Mean survival time was 39±3.9 months for the study population. Tamura texture features, directionality, coarseness and contrast were independently associated with patient survival ($p<0.01$). The trained SVM model that included standard clinical and pathological prognostic variables resulted in an area under the ROC curve of 0.80. An SVM model that adds imaging-based heterogeneity features to the clinical and pathological variables resulted in improved model performance for survival prediction with an AUC of 0.98 ($p<0.001$).

CONCLUSION

MRI-based texture features improve the performance of standard clinical and pathological variables for predicting patient survival in metastatic colorectal cancer.

CLINICAL RELEVANCE/APPLICATION

Machine learning-based predictive models incorporating quantitative MRI heterogeneity features may improve prognostication and personalize treatment choices in patients with metastatic colon cancer.

SSC05

Gastrointestinal (Small Bowel Imaging)

Monday, Nov. 27 10:30AM - 12:00PM Room: E451A

GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSC05-01 Development and Validation of simplified Magnetic Resonance Index of Activity (sMARIA)

Monday, Nov. 27 10:30AM - 10:40AM Room: E451A

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PURPOSE

MaRIA index is the most used Magnetic Resonance Enterography (MRE) index in clinical trials for luminal Crohn's disease (CD). However, a number of limitations had been recognized. The aim of this study is to develop and to validate a simplified and accurate Magnetic Resonance Index of activity (sMaRIA) for assessing activity and therapeutic response on patients with luminal CD.

METHOD AND MATERIALS

MRE data from 98 patients, including active and inactive disease on the colon and/or terminal ileum, from two prospective studies were re-analysed to develop the sMaRIA using endoscopy (CDEIS) as gold standard. Further analysis of responsiveness in a cohort of 48 patients who underwent MRE and endoscopy at screening and after 12 weeks of therapy with antiTNF or corticoids was performed. Comparison between MaRIA and sMARIA for detecting active/severe lesions and therapeutic response was performed.

RESULTS

Logistic regression analysis showed that wall thickness >3 mm, presence of edema, ulcers and fat stranding were independent predictors for assessing CD activity and were used as descriptors of sMaRIA. The sensitivities and specificities of sMaRIA at segment level for detecting active disease using a cutoff >=5 were 90% and 81% (AUC 0.91), and for detecting severe lesions at endoscopy (presence of ulcerations) using a cutoff >=10 were 85% and 92% (AUC 0.93). Correlation between sMaRIA and CDEIS was r=0.82 and with MaRIA r=0.91 (p<0.0001). Sensitivities and specificities of sMaRIA were no statistically significant different from MaRIA for detecting activity (p=0.07 and p=0.2 respectively) or for detecting severe lesions (p=0.5 and p=0.5 respectively). The sensitivity and specificity of sMaRIA for detecting endoscopic remission (CDEIS<3.5) using a cutoff<5 were 82% and 88% (AUC 0.88), and for detecting ulcer healing at endoscopy using a cutoff <10 were 64% and 96% (AUC 0.93).

CONCLUSION

The simplified MaRIA index is as accurate as the MaRIA for detecting active and severe inflammation, and also has high diagnostic accuracy for detecting therapeutic response. Main advantages over MaRIA includes simplicity, its calculation is less time consuming and accounts for missing segments.

CLINICAL RELEVANCE/APPLICATION

Simplified MaRIA index allows a fast and simple assessment of inflammation activity on CD by keeping high accuracy for both diagnosis and therapeutic response.

SSC05-02 Intravoxel Incoherent Motion Diffusion-weighted MRI Detection and Grading of Bowel Wall Fibrosis in Crohn's Disease

Monday, Nov. 27 10:40AM - 10:50AM Room: E451A

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PURPOSE

To determine the value of intravoxel incoherent motion (IVIM) diffusion-weighted MRI (DWI) for detecting and grading bowel wall fibrosis in adults with Crohn's disease (CD).

METHOD AND MATERIALS

17 adult patients (8 men, 9 women; mean age: 31.75 ± 8.58 years) with CD underwent pre-operative IVIM-DWI. The free-breathing IVIM-DWI was obtained using a single-shot spin-echo echo-planar imaging sequence with 13 b values (contains 0 - 2000 mm/s2) on a 3T MR system with eight-channel phased-array body coils. The perfusion-related fraction (*PF*), perfusion-related coefficient (*D**), and diffusion-related coefficient (*D*) of abnormal bowel segments were calculated using a bi-exponential model with constrained least squares algorithm. Mural fibrosis of the resected bowel segments was scored 0-3 histologically. The vessel density was assessed by immunohistochemistry using panendothelial cell antigen CD31.

RESULTS

In 77 surgical specimens sampled from 17 patients, the correlation between the *PF* values and histologic fibrosis scores was significantly inverse (r = -0.675, P<0.001). The *PF* values significantly decreased with increasing severity from mild, moderate, to marked fibrosis (P<0.001). ROC curve analysis showed high accuracy of *PF* values with an AUC of 0.885 (95% confidence interval: 0.79-0.97, P<0.001) for differentiating moderate-severe from mild bowel wall fibrosis. Using threshold *PF* value of 0.33, the sensitivity and specificity for differentiating between moderate-severe fibrosis and mild fibrosis were 95.50% and 81.80%, respectively. The *D* and *D** values were not significantly correlated with histological fibrosis. There was no significant association between IVIM parameters and vessel density.

CONCLUSION

Bowel wall fibrosis in CD correlates with perfusion rather than pure diffusion. The *PF* value decreases with severity and is useful to detect and grade fibrosis.

CLINICAL RELEVANCE/APPLICATION

Free-breathing IVIM-DWI without contrast administration is a potential biological marker of bowel perfusion and may be beneficial for treatment planning and monitoring bowel wall fibrosis of CD in adults.

SSC05-03 Towards Development of a CT Enterography Severity Score for Small Bowel Crohn's Disease

Monday, Nov. 27 10:50AM - 11:00AM Room: E451A

Awards
Student Travel Stipend Award

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PURPOSE

CT and MR enterography (CTE, MRE) are used to objectively measure small bowel Crohn's disease inflammation. Quantitative severity scores have been developed for MRE (i.e., MaRIA score), but no CT severity scoring system exists.

METHOD AND MATERIALS

Patients with biopsy-proven Crohn's disease with CTE and MRE within 30 days were identified. A GI radiologist examined CTE images for ulceration, mural edema, comb sign, perienteric stranding and fistulae involving the distal 10 cm of terminal ileum (TI), and measured wall thickness and attenuation. The CT EMBARK score (a visual score from 1 to 3, for enhancement, wall thickness, and ulceration) was assigned. MaRIA scores for the TI were separately calculated by an abdominal imaging fellow for each MRE. Total lengths of inflamed ileal segments were measured by both radiologists. Statistical modeling (i.e., linear models, regularized linear models, and Random Forests) was conducted to predict the MaRIA scores based on CT findings. Performance of fitted models was assessed by R-square (R2).

RESULTS

43 patients (18 M, 25 F) had CTE and MRE within a mean of 4 days (range 0-28). By MRE, 27 (63%) patients had evidence of active TI inflammation (mean MaRIA score 17±12; mean inflamed length 13±11 cm). By CTE, 30 (70%) had active TI inflammation (mean inflamed length 13±11 cm), with 8 (19%) showing ulceration, 19 (44%) mural edema, 9 (21%) comb sign, 6 (14%) perienteric stranding and 1 (2%) fistula. Association of the CTE severity scores with MaRIA score ranged from R2 = 0.60 for the

visual EMBARK score to R2=0.93 for the Random Forest model with all CT features considered. A parsimonious linear model, with variables informed through variable selection in a cross-validated regularized (elasticnet) regression model, was as follows: Predicted MaRIA = 2.90 + 2.78 * CT Wall Thickness + 5.72 (if Perienteric Stranding is present) + 6.72 (if Ulceration is present). This model performed well (R2 = 0.64). ICC for length measurements was 0.82 (95% CI: 0.70 to 0.90).

CONCLUSION

We determined CT features and weightings to calculate a CT severity score similar to MaRIA. Further work will be required to finalize and validate the scoring system.

CLINICAL RELEVANCE/APPLICATION

Because CT imaging is used to guide management in symptomatic Crohn's disease, a CT severity score similar to MaRIA has been developed to measure inflammatory severity and quantify therapeutic response.

SSC05-04 MR T2* Mapping Helps to Characterize Intestinal Fibrosis in Patients with Crohn's Disease

Monday, Nov. 27 11:00AM - 11:10AM Room: E451A

Awards
Student Travel Stipend Award

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PURPOSE

The assessment and quantification of fibrosis in Crohn's disease (CD) patients has important therapeutic implications. T2* mapping has the potential to reflect small changes in the biochemical components of the counterpart tissue without contrast medium injection. We first aimed to determine the utility of T2* mapping for grading diverse degrees of intestinal fibrosis using surgical pathology as reference standard.

METHOD AND MATERIALS

This was an observational study of 20 CD patients who underwent an MR T2*WI scan within 15 days before elective enterectomy. The T2* values of the bowel wall to be resected were measured for each region. Resected bowel tissues with pathological fibrosis and type I collagen were classified into four severity grades (from 0 to 3).

RESULTS

Eighty-six surgical specimens from twenty patients were analyzed, including non-fibrotic (n=1) and mild (n=14), moderate (n=48) and severe (n=23) fibrosis specimens. The T2* value differences of the fibrotic segments among non-fibrotic or mild, moderate and severe CD patients were significant (all P<.001). The T2* values were moderately associated with the histologic fibrosis (r=-0.687, P<.001) and type 1 collagen scores (r=-0.588, P<.001). T2*mapping could discriminate no or mild fibrosis (grade 0-1) from moderate-severe (grade 2-3) fibrosis deposition with an area under the receiver operating characteristic (ROC) curve of 0.939, which included a sensitivity of 84.6% and a specificity of 93.2%. A threshold T2* value of 21.84 was recommended for differentiating no or mild fibrosis from moderate-severe fibrosis.

CONCLUSION

T2*mapping is capable of detecting and distinguishing between certain degrees of bowel fibrosis in CD lesions. T2* mapping might be a potentially novel imaging tool for the evaluation of fibrotic stricture in CD patients.

CLINICAL RELEVANCE/APPLICATION

The T2* value is sensitive to small changes in biochemical composition, which suggests that lesion properties, particularly the transformation of water mobility within the macromolecular network, reflect the varying phase and status of CD. The T2* values were highly accurate for differentiating non- or mildly fibrotic and moderate-severe fibrotic bowel walls in CD patients. This may be important in further stratifying CD patients regarding the disease severity or suitability for modifying disease therapy.

SSC05-05 DECT in Bowel Inflammation Assessment on Low KeV Images

Monday, Nov. 27 11:10AM - 11:20AM Room: E451A

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PURPOSE

Low mono-energetic image derived by Dual Energy CT (DECT) can enable greater attenuation of contrast and improve conspicuity

Low mono-energetic image derived by Dual Energy CT (DECT) can enable greater attenuation of contrast and improve conspicuity. We hypothesized the low mono-energetic image will improve the reliability in the assessment of bowel inflammation. We aimed to compare conventional abdominal contrast-enhanced CT images with the low mono-energetic and virtual-non-contrast (VNC) DECT images to assess the contrast enhancement, contour and related findings in acute bowel inflammation.

METHOD AND MATERIALS

Forty patients who underwent abdominal contrast enhanced DECT (IQon, Philips Healthcare, Eindhoven, Nederland) between January and April 2017, with radiological findings correlating to bowel inflammation were retrospectively reviewed. Contrast enhanced series were performed using conventional single-energy mode at 120 kV. VNC and mono-energetic (ME) images at 50 keV were reconstructed from the conventional study. Qualitative assessments of the inflamed bowel wall, mural or intra luminal findings, adjacent fat stranding and fluid were performed on the conventional, VNC and ME images and rated on a scale of 1-5 (5 being the highest). Paired t-test was used to assess the significance of the differences between the conventional, VNC and ME images.

RESULTS

Bowel inflammation was cause by acute appendicitis (15%, 6/40), bowel obstruction (35%, 14/40), tumor (20%, 8/40) and colitis (30%, 6/40). The score of the qualitative assessment on the ME images at 50 keV (4.7) was significantly higher ($p<0.001$) compared to the score on the conventional image (3.9) The qualitative assessment had a lower score on the VNC image compared to the conventional image, with no significant difference.

CONCLUSION

Virtual low mono-energetic DECT images have the ability to significantly improve the conspicuity of bowel inflammation assessment. Non-conclusive radiological findings may thus be turned into definite and clinically relevant studies.

CLINICAL RELEVANCE/APPLICATION

The diagnostic yield of bowel inflammation can be increased with the use of mono-energetic images at low keV and therefore avoid non-conclusive radiological reports. This may assist in the clinical therapeutic decision making.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Jacob Sosna, MD - 2012 Honored Educator

SSC05-06 Natural History of Endoscopic Skipping of the Terminal Ileum (ESTI): Incidence of Isolated Radiographic Intramural Inflammation

Monday, Nov. 27 11:20AM - 11:30AM Room: E451A

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PURPOSE

ESTI refers to a normal appearance of the terminal ileum (TI) at ileocolonoscopy (ICO) despite active small bowel (SB) Crohn's disease as evidenced by SB inflammation proximal to ICO, isolated radiographic findings of intramural inflammation (IMI) in the TI, or positive biopsy (microscopic inflammation). Our purpose is to evaluate the natural history of ESTI and the incidence of IMI in Crohn's patients.

METHOD AND MATERIALS

Patients were included who had normal ICO and CT/ MR enterography (CT/MRE) performed within 30 days showing active TI inflammation, as well as follow-up CTE/MRE. Severity of TI inflammation was assessed using a 4 point scale: 0: None; 1: hyperenhancement w/o thickening; 2: w/ >=5 mm thickness; 3: ulcers or > 10 mm in thickness. The length of TI involvement was recorded. Endoscopy and pathology reports were reviewed for length of TI intubation, endoscopic impression, and biopsy results. Patients were evaluated for new or worsening SB inflammation or stricture formation on subsequent CTE/MRE. Development of TI ulcers or inflammation detected on subsequent endoscopy or surgery was recorded. Patients with ESTI were then classified as: confirmed inflammation (subsequent worsening TI severity/length, new ulceration, or need of surgery); probable inflammation (decreased inflammation with medical therapy); inflammation unlikely.

RESULTS

113 patients had ESTI, 72 (64%) - IMI; 11 (10%) - proximal SB inflammation; 30 (27%) - microscopic and radiographic inflammation. 68 patients (60%) had confirmed inflammation, 14 (12%) - probable inflammation, and 31 (28%) - inflammation unlikely. Confirmed Inflammation was verified by subsequent surgery (n=40), positive ICO (n=41), worsened SB inflammation/stricture (n=39), and most had (IMI) (n=43/68; 63%). Median severity score and length were highest for confirmed inflammation (2, 10 cm) versus probable inflammation (1.5, 6 cm) and inflammation unlikely (1, 2 cm).

CONCLUSION

Patients with ESTI identified by CTE/MRE and who have more than 2 cm of inflammation with wall thickening >= 5mm will have

Patients with ESTI identified by CTE/MRE and who have more than 2 cm of inflammation with wall thickening >= 3mm will have inflammatory Crohn's, which worsens over time, or which will respond to medical therapy. About two-thirds of patients with ESTI have IMI, which behaves similarly.

CLINICAL RELEVANCE/APPLICATION

SB Crohn's disease should be monitored by endoscopy and enterography, as endoscopic skipping of the TI and isolated radiographic intramural inflammation will progress unless it is treated medically.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Michael L. Wells, MD - 2017 Honored Educator

SSC05-07 Quantitative Inflammation Assessment for Crohn's Disease Using Ultrasound Microvessel Imaging: A Pilot Study

Monday, Nov. 27 11:30AM - 11:40AM Room: E451A

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PURPOSE

To evaluate Crohn's Disease (CD) bowel wall inflammation using the quantitative flow measurements derived from ultrasound microvessel imaging (UMI).

METHOD AND MATERIALS

Forty-four bowel wall segments (28 terminal ileum, 5 neoterminal ileum, 5 small bowel, 4 colon, 2 ileum) from 33 patients with CD symptoms undergoing CT or MR-enterography were imaged with UMI. UMI was performed with an ultrafast plane wave imaging system (Vantage, Verasonics Inc.) and a 5MHz linear array transducer (frame rate = 500 Hz, ensemble length = 250). A block-wise adaptive singular value decomposition (SVD)-based clutter filter was used extract the microvessel signal (Fig. (b)). UMI has significantly higher Doppler sensitivity than conventional Doppler (Fig. (a)). The dynamic range of the UMI images was carefully adjusted to reject background noise. Bowel wall microvessel density (MVD) was then calculated by measuring the number of microvessel pixels in the bowel wall and then normalizing to the bowel wall length. Bowel wall microvessel flow speed index (MVFS) was measured by calculating the local microvessel blood speckle decorrelation coefficient (faster flow speed leads to higher decorrelation), integrating the coefficient throughout the entire bowel wall, and normalizing to the bowel wall length. The CTE and MRE results were used as the reference standard for inflammation assessment.

RESULTS

Figures (c) and (d) show the MVD and MVFS measurements for normal, mild inflammation and active inflammation bowels. Active inflammation has significantly higher (p<0.05, one-tailed t-test) MVD and MVFS than normal and mildly inflamed bowels. MVD was significantly higher in mild than in normal bowel, while MVFS difference was not significant (p=0.07). A ROC analysis of using MVD to differentiate normal from inflamed (mild and active) bowel gave a sensitivity of 0.90, specificity of 0.85, and AUC of 0.96; differentiate active from normal and mild bowel gave a sensitivity of 0.96, specificity of 0.83, and AUC of 0.94.

CONCLUSION

The high Doppler sensitivity of UMI reveals bowel wall microvessels that are invisible to conventional Doppler. The quantitative microvessel measurements show promise of staging CD bowel wall inflammation.

CLINICAL RELEVANCE/APPLICATION

Reliable inflammation assessment for CD is essential to evaluate therapy efficacy and potential need for treatment modification. UMI offers a safe and cost effective tool for long term follow-up of CD.

SSC05-08 Consecutive Case Series of Pathologically Proven Small Bowel Neuroendocrine Neoplasms: Impact of Imaging Technologies

Monday, Nov. 27 11:40AM - 11:50AM Room: E451A

Awards
Student Travel Stipend Award

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PURPOSE

Neuroendocrine neoplasms are now the most common small bowel neoplasm. We conducted a retrospective review of small bowel neuroendocrine neoplasms (SBNEN) to determine: (1) frequency and diagnosis by various imaging modalities, (2) the impact of CT enterography (CTE) on diagnosis, and (3) rates of disease-free survival.

METHOD AND MATERIALS

Histopathologically confirmed SBNEN from 01/1996 - 02/2016 were identified, including those first diagnosed with SBNEN at our institution (FD-SBNEN). Clinical presentation, radiology, endoscopy, surgery, and pathology reports were reviewed and compared at 5-year periods.

RESULTS

294 SBNEN were included (178 FD-SBNEN). Diagnosis of SBNEN increased significantly (15 in 1996-2000, 168 in 2011-2016). GI bleeding increased as clinical presentation for FD-SBNEN (0% in 1996-2000, 25.4% in 2011-2016, p = 0.023). FD-SBNEN diagnosed by radiology increased 2-fold (n=3, 33.3% in 1996-2000; n=75, 65.8% in 2011-2016). The other primary diagnostic modality was EGD (n=3, 33.3% in 1996-2000; n=27, 23.7% in 2011-2016). For FD-SBNEN, CTE identified SBNEN 95% (52/55), with 91% (50/55) of original clinical reports diagnosing SBNEN. Routine abdominal CT detected 45% (37/85) and diagnosed 35% (29/85) of SBNEN. Of the 39 FD-SBNEN discovered by endoscopy, the recurrence rate correlated to initial lesion size; e.g., only 18% of SBNEN measuring 0.6± 0.3 cm recurred, but 75% measuring 3.7±1.0 cm recurred. Rates of disease-free survival during following resection for FD-SBNENs (n=96) was better when tumors were first identified by CTE rather than alternative radiologic methods (85% n=35 vs. 57% n=31, p=0.0034). Rates of local metastases (4.9% n=2 vs. 18.5% n=10, p=0.0475) and liver metastases (2.4% n=1, 24.1% n=13, p=0.0032) were also lower when CTE discovered SBNEN.

CONCLUSION

In the last two decades, there has been a dramatic increase (over 10-fold at our institution) in SBNEN's detected by CTE and endoscopy, and in patients with small bowel bleeding. SBNEN detection and characterization is better with CTE than routine abdominal CT. Small SBNEN's detected at endoscopy and CTE have longer disease-free survival.

CLINICAL RELEVANCE/APPLICATION

There has been a dramatic increase in SBNEN's detected by CTE and endoscopy, especially in patients with small bowel bleeding. Those with small tumors detected at endoscopy and CTE have longer disease-free survival after surgical resection.

SSC05-09 A New Semi-Automatic Technique for Crohn's Disease Diagnosis Using Supervised Machine Learning Algorithm: Kernel Support Vector Machine

Monday, Nov. 27 11:50AM - 12:00PM Room: E451A

Awards
Student Travel Stipend Award

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PURPOSE

We propose a new semi-automatic technique for Crohn's disease (CD) diagnosis, using Kernel Support Vector Machine (KSVM). KSVM is a supervised machine learning algorithm, which, instructed by a set of "labeled training example", outputs a function used to classify brand new data.

METHOD AND MATERIALS

Three radiologists extracted a dataset composed of 300 MR Enterography of 300 different patients used for KSVM training and validation. Each patient - classified in positive and negative according to histological specimen results - was "labeled" by 22 determined qualitative features, which are associated to CD or may help in CD diagnosis, according to worldwide literature: Terminal ileum thickening, length of the affected segment/s, single/skip lesions, fat wrapping, pseudo-polyps, ascites, stenosis/sub-stenosis, previous ileo-colonic surgery, sinus, fistulas, disease pattern and activity, complications, intestinal obstruction, lymph nodes, artifacts, enhancement pattern, parietal signal intensity on T2 SPAIR, signal intensity on DWI, bowel loops cleansing and distention. 300 MR enterography were divided as follows: 4/5 (240 patients) were used for KSVM training, and 1/5 (60 patients) were used for KSVM validation. This technique adopts a Stratified K(5)-Fold Cross-Validation strategy to enhance KSVM classifier reliability:

dataset is divided into k equal subsets, and the holdout method is repeated k times. Each time, one of the k subsets is used as validation set and the other K-1 subsets are put together to form the training set. So, the average error and/or any patient selection pitfall across all K experiments are computed and reduced.

RESULTS

The KSVM results were compared with the histological specimen results: Sensitivity: 94,80%; Specificity: 100,00%; Negative Predictive Value: 95,06%; Precision: 100,00%; Accuracy: 97,40%; Error: 2,60%.

CONCLUSION

The achieved results show that the proposed technique results are better than the manual reference methods reported in literature (Sensitivity: 93,00%; Specificity: 90,00%) with a greater usability and degree of acceptance.

CLINICAL RELEVANCE/APPLICATION

Crohn's Disease (CD) diagnosis using MRI requires great radiological expertise in gastrointestinal field. We propose a new semi-automatic technique for CD diagnosis, using machine learning algorithm.

SSC06

Genitourinary (Renal Mass Imaging)

Monday, Nov. 27 10:30AM - 12:00PM Room: N230B

CT GU OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSC06-01 Prospective Comparison of RECIST and Alternative Response Assessment Criteria Using Normalized Enhancement Values in the Evaluation of Metastatic Renal Cell Cancer Patients from Phase II of the Multi-Centre STAR Trial

Monday, Nov. 27 10:30AM - 10:40AM Room: N230B

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Vicky J. Goh, MBBCh, London, United Kingdom (*Abstract Co-Author*) Research Grant, Siemens AG Speaker, Siemens AG

PURPOSE

Size and enhancement response criteria have been advocated for tumor assessment in metastatic renal cancer with the potential to predict earlier response or progression. We aimed to assess the difference in categorical response using RECIST 1.1, Choi and modified Choi (mChoi) criteria with normalised enhancement values between different readers on Computed Tomography (CT) as part of a prospective multicentre study.

METHOD AND MATERIALS

Following IRB approval and informed consent, 44 prospective patients enrolled in phase II of the STAR trial comparing treatment strategies of tyrosine kinase inhibitor therapies in metastatic renal cell carcinoma were assessed at baseline, 12 and 24 weeks post therapy commencement. Contrast enhanced CT scans were assessed by 2 radiologists: 104 target lesions were assessed using commercial semi-automated software. The sum of longest diameter of tumor target lesions and tumor normalised enhancement values (calculated relative to aortic attenuation) and subsequent percentage change at 12 week and 24 week CT were measured. Response categorisation by RECIST, Choi and mChoi criteria into stable disease (SD), partial response (PR) or progressive disease (PD) was undertaken, and discrepant cases identified. Cohen's kappa coefficients were calculated to assess reader agreement.

RESULTS

26 patient at 12 weeks had discrepant categories of response: PR by Choi/mChoi criteria but SD by RECIST. 13 became PR by RECIST at 24 weeks and 13 patients remained discrepant: PR by Choi/mChoi but SD by RECIST. At 12 week follow up, there was excellent reader concordance for RECIST (k 0.9 n=44) and modified Choi categorisation (k 0.9 n=43), decreasing for Choi criteria (k 0.76 n=42). At 24 weeks there was substantial agreement for RECIST (k 0.8 n=44) and modified Choi categorisation (k 0.79 n=40) with complete agreement of Choi categorisation (k 1 n=41). 5 patients had PD at 24 weeks, with complete agreement.

CONCLUSION

Early tumor response, confirmed on 24 weeks, was noted more frequently for Choi/mChoi than RECIST criteria. Substantial to excellent agreement was observed in response categorisation across all criteria.

CLINICAL RELEVANCE/APPLICATION

Choi/mChoi criteria using normalised enhancement values predict tumour response at 12 weeks, confirmed at 24 weeks with excellent observer agreement.

SSC06-02 Parapelvic Cysts: An Ultrasonographic Clue for Differential Diagnosis in Fabry Disease

Monday, Nov. 27 10:40AM - 10:50AM Room: N230B

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PURPOSE

Fabry Disease (FD) is a rare inherited multi-systemic lysosomal storage disorder, related to a lack of activity of a-galactosidase. Kidney involvement in FD is common and linked to globotriaosylceramide deposition in all types of renal cells, with subsequent progression in untreated patients to end stage renal failure. Parapelvic cysts (PC) have been already described in literature as a possible feature of FD; nevertheless, their exact prevalence and their meaning in renal FD involvement remain uncertain. Aim of this study is to assess the actual prevalence of PC in a representative cohort of FD patients by renal ultrasound.

METHOD AND MATERIALS

We performed a restorspective multicentric study on 173 FD patients (Study 1), comparing the results with a second group of 67 FD patients analysed by the same ultrasonographer in a single center (Study 2). Age- and renal function-matched healthy controls (HC) were selected for comparison. Inclusion criteria were genetically proven FD and age>=18y, while exclusion criteria were renal replacement therapy and presence of renal malformations. Clinical and biochemical data concerning renal impairment were collected by trained physicians. Ultrasonographic examination included determination of renal diameters, presence of PC and cortical cysts or other renal abnormalities.

RESULTS

In Study 1, PC were detected in 28.9% of FD subjects and in 1.1% of control subjects ($p<0.001$); presence of other renal abnormalities and biochemical alterations did not differ between groups. In Study 2, prevalence of PC raised from 29.8% to 43.3% ($p<0.05$), due to a better accuracy in US examination. In both studies, no correlation was detected between PC. Finally, no difference was found between FD patients with and without PC.

CONCLUSION

Our results confirm the higher prevalence of PC in classical FD subjects compared to HC, highlighting the role of accurate US renal examination in their detection. Resort to CT or MRI should be considered only in case of ambiguous US findings.

CLINICAL RELEVANCE/APPLICATION

Although to date parapelvic cysts cannot be considered a pathognomonic sign of FD, their presence should induce to consider FD among differential diagnosis in subjects with unclear personal and family history of renal disease, in order to prevent disease progression.

SSC06-03 Clear Cell Renal Cell Carcinoma Treated by Antiangiogenic Therapy: Distribution of Metastatic Sites at Baseline and at Time of Progressive Disease Determination

Monday, Nov. 27 10:50AM - 11:00AM Room: N230B

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PURPOSE

Clear cell renal cell carcinoma (ccRCC) is the most prevalent and one of the most lethal RCC subtypes with a high potential for distant metastases. Angiogenesis influences hematogenous dissemination and metastatic distribution. Because anti-angiogenic therapy is first-line therapy for metastatic ccRCC, it is necessary to understand if sites of metastatic disease vary in patients treated with this treatment modality. The purpose of this study was to evaluate alterations in metastatic disease distribution between initial presentation and at time of progressive disease (PD) in a cohort of patients with metastatic ccRCC treated with VEGFR tyrosine kinase inhibitors.

METHOD AND MATERIALS

With IRB approval, we analyzed a cohort of patients enrolled in a Phase III multi-center open label trial who were randomized 1:1 to open label anti-VEGFR tyrosine kinase therapies. All patients had previously progressed after having received, at a minimum, first line VEGFR tyrosine kinase inhibitor therapy and had measurable metastatic disease at screening. A chest CT, and either a CT or MRI of the abdomen and pelvis were acquired at screening and every eight weeks, from over 150 global sites, and processed and interpreted at an imaging core laboratory for radiological progression using RECIST 1.1.

RESULTS

The study cohort included 397 patients (297 (75%) men and 100 (25%) women) with confirmed PD on imaging, with a mean age of 60.7 years (+/- 10.0). The four most common sites of metastatic spread at baseline and at the time of progression were lymph nodes (29.8%, 29.1%), lung (27.1%, 25.4%), liver (10.9%, 11.2%), and bone (8.6%, 11.5%), respectively. The most common sites of new lesions were bone (31.8%), lymph nodes (21.5%), liver (14.0%), and lung (13.3%).

CONCLUSION

The four most common sites for ccRCC metastatic disease are the lymph nodes, lungs, liver, and bones. Over the course of a clinical trial the overall sites at time of disease progression are the same as at screening, but the most common site for new lesions to develop is bone.

CLINICAL RELEVANCE/APPLICATION

Knowing common sites of metastatic disease in patients with ccRCC treated with targeted therapy can improve lesion detection in clinical practice and in therapeutic trials.

SSC06-04 Wavelets Analysis for Differentiating Solid, Non-Macroscopic Fat Containing, Enhancing Renal Masses: A Pilot Study

Monday, Nov. 27 11:00AM - 11:10AM Room: N230B

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PURPOSE

To evaluate potential use of wavelets analysis in discriminating benign and malignant renal masses (RM)

METHOD AND MATERIALS

In this IRB approved study, we evaluated 144 patients with predominantly solid, non-macroscopic fat containing, enhancing RM. 98 cases were malignant renal cell carcinoma (RCC) and 46 cases were benign RM: oncocytoma, lipid-poor angiomyolipoma. The Haar wavelet was used to analyze the grayscale images of the largest segmented tumor in the axial direction using Matlab® (Mathworks, Natick, MA) software. Six metrics (energy, entropy, homogeneity, contrast, standard deviation (SD) and variance) derived from 3-levels of image decomposition in 3 directions (horizontal, vertical and diagonal) respectively, were used to quantify tumor texture. Independent t-test or Wilcoxon rank sum test depending on data normality were used as exploratory univariate analysis. Stepwise logistic regression and ROC curve analysis were used to select predictors and assess prediction accuracy, respectively.

RESULTS

Consistently, 5 out of 6 wavelet-based texture measures (except homogeneity) were higher for malignant tumors compared to benign, when accounting for individual texture direction. Homogeneity was consistently lower in malignant than benign tumors irrespective of direction. SD and variance measured in the diagonal direction on the cortico-medullary phase showed significant ($p<0.05$) difference between benign versus malignant tumors. The multivariate model with average variance (across all 3 directions) and SD (along the vertical direction) extracted from the excretory and pre-contrast phase, respectively showed an AUC of 0.7 ($p < 0.05$) in discriminating malignant from benign. Additionally, AUC of 0.86 ($p < 0.05$) was obtained in discriminating oncocytoma (26) from clear cell RCC (68). The top predictors in the latter model discriminating RM subtypes included variance and homogeneity in the pre-contrast phase (diagonal) and, SD and entropy in the cortico-medullary phase (horizontal).

CONCLUSION

Wavelet analysis is a valuable texture evaluation tool to add to radiomics platforms geared at reliably characterizing and stratifying renal masses.

CLINICAL RELEVANCE/APPLICATION

Improved differential diagnosis based on better discrimination of the tumor types will provide patient-specific care-management options

SSC06-05 Variability of Texture Features Extracted from Contrast-Enhanced Computed Tomography Images of Renal Tumors: Role of Necrosis

Monday, Nov. 27 11:10AM - 11:20AM Room: N230B

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PURPOSE

CT texture analysis (CTTA) is popular tumor stratification tool. CTTA assumes CT attenuation patterns (image) depend on tumor-type, microvessel density, intratumoral necrosis and thus, indicative of tumor heterogeneity. Here we evaluate the effect of necrosis on CTTA features in differentiating benign from malignant renal masses (RM).

METHOD AND MATERIALS

In this retrospective study, we identified 144 patients with non-macroscopic lipid containing, predominantly solid, enhancing renal tumors based on post-surgical pathology examination (98 malignant renal cell carcinoma and 46 benign RM: oncocytoma, lipid-poor angiomyolipoma). CECT images of RM were used as inputs to a CTTA panel. The panel comprised of 29 different texture metrics derived using 6 methods: histogram analysis, gray-level co-occurrence matrix method and gray-level difference matrix method, spectral (fast fourier analysis), in both 2D and 3D. Tumor necrosis ranged from 1-30% of tumor volume (-10 to +15 HU; non-enhancing areas). Data normality was examined using D'Agostino's K2 test. Generalized linear model with an interaction term was used to test the difference of the difference (benign vs. malignant; with and without necrosis).

RESULTS

Histogram-based: variance and spectral-based: entropy of spectral magnitude, entropy of spectral phase, and complexity index (sum of spectral harmonics between 25-75% of the maximum frequency) showed significant ($p < 0.01$) difference between the benign and malignant group while taking into account the necrotic regions. Similar results were obtained while removing necrotic regions but the results were significantly ($p < 0.01$) different from those when necrosis was included. The results were consistent across all 4 CECT phases. In general, the malignant tumors showed higher variance, complexity index and entropy of spectral-magnitude, all of which are indicative of increased heterogeneity compared to benign tumors. Other metrics had mixed results with variable significance depending on necrosis status.

CONCLUSION

Standardized methods of identifying CT-based necrosis are warranted in lesions analysis particularly in whole lesions, where the analysis cannot be limited to non-necrotic region.

CLINICAL RELEVANCE/APPLICATION

The removal of necrotic tumor regions allows better representation of the radiomic signal from the remainder of the lesion leading to improved accuracy rate of differentiating benign and malignant enhancing RM.

SSC06-06 Subjective and Quantitative Computed Tomography (CT) Analysis to Differentiate Low Grade from High Grade Chromophobe Renal Cell Carcinoma

Monday, Nov. 27 11:20AM - 11:30AM Room: N230B

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PURPOSE

This study evaluates the ability of unenhanced CT to differentiate low versus high grade ch-RCC using subjective and quantitative analyses.

METHOD AND MATERIALS

With IRB approval, 37 ch-RCC (high grade N=13, low grade N=24) with pre-operative unenhanced CT were identified between 2012-2016. Two blinded radiologists (R1/R2) subjectively evaluated: tumor margin (smooth or irregular/spiculated), homogeneity (homogeneous, mildly or markedly heterogeneous) and calcification. A third blinded radiologist measured unenhanced CT attenuation (Hounsfield Units [HU]) and contoured tumors so that previously described texture analysis features studied in RCC could be extracted. Quantitative variables in this study were selected to potenitally correlate with the histological grading system for ch-RCC proposed by Paner et al. which includes nuclear-to-cytoplasmic ratio (attenuation) and anaplasia (heterogeneity). Comparisons were performed using chi-square, independent t-tests and logistic regression. Accuracy for diagnosis was assessed using ROC. Inter-observer agreement was calculated with Cohen's kappa statistic.

RESULTS

There were no differences in patient age or gender between groups (p=0.65 and 0.07). High grade tumors were larger (62.6 ± 34.9 mm [17.0-141.0]) than low grade tumors (39.0 ± 17.9 mm [16.0-72.3]) and showed higher attenuation (45.5 ± 8.2 HU [29.0-55.0] versus 35.3 ± 8.5 HU [14.0-51.0]), (p=0.01 and <0.01). Higher grade tumors were more frequently calcified (38.5% [5/13] R1 and 46.2% [6/13], p=0.03) and showed irregular/spiculated margins (46.2% [6/13] R1 and 69.2% [9/13], p=0.02). Agreement was moderate (K=0.47 and 0.36). Higher grade tumors were more frequently heterogenous (30.8% [4/13] R1 and 23.1% [3/13] R2 considered homogeneous, p=0.01). Agreement was also moderate (K=0.57). Quantitatively, run-length nonuniformity and gray-level nonuniformity (as described in the article by Schieda et al. who assessed texture analysis in CT to diagnose sarcomatoid RCC) were higher in high grade RCC (p<0.05) and could diagnose high grade tumors with moderate-to-good accuracy (area under curve 0.80).

CONCLUSION

Size, calcifications, irregular/spiculated margins, attenuation and heterogeneity at unenhanced CT are features associated with

high grade ch-RCC.

CLINICAL RELEVANCE/APPLICATION

High grade ch-RCC can be suspected at unenhanced CT when tumors are larger, calcified, have higher attenuation and are more heterogeneous.

SSC06-07 Differentiation of Clear Cell Papillary Renal Cell Carcinoma from Clear Cell and Papillary Subtypes on Multiphasic Computed Tomography

Monday, Nov. 27 11:30AM - 11:40AM Room: N230B

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PURPOSE

To determine if clear cell papillary renal cell carcinoma (ccpRCC) can be differentiated from clear cell (ccRCC) and papillary renal cell carcinoma (pRCC) on computed tomography (CT).

METHOD AND MATERIALS

An IRB-approved, retrospective review of our institutional surgical pathology database identified 23 ccpRCC, 46 ccRCC, and 51 pRCC from 2011-2016. Pre and post operative CT scans were reviewed and imaging features were compared. Statistical analysis was performed by ANOVA, sensitivity and specificity by ROC, and cutoff points established via a maximum Yoden index.

RESULTS

Compared to ccRCC, ccpRCC was more likely to have smooth rather than heterogeneous margins (p=0.012), less avid arterial attenuation (79.9±45.4 HU) (125.0±45.9 HU, p=0002), and progressive enhancement (rather than washout) on nephrographic phase. ccpRCC can be distinguished from ccRCC using an attenuation cutoff of 76 HU on arterial phase (sens 0.91, spec 0.64, p=0.005) and 45 HU enhancement between unenhanced and arterial phase (sens 0.85, spec 0.65, p=0.009). Compared to pRCC, ccpRCC was more likely to be heterogeneous (p=0.002), have higher nephrographic attenuation (88.8±35.8 HU) than pRCC (65.7±17.8 HU, p=0.031), and show similar progressive enhancement on nephrographic phase. There was no difference in unenhanced attenuation between the 3 subtypes. ccpRCCs were significantly smaller (2.8±1.5cm) than either ccRCC (5.6±3.4cm, p = 0.001) or pRCC (5.6±4.6 cm, p = 0.004). None of the ccpRCC demonstrated calcification, macroscopic fat, adenopathy, venous invasion, or metastatic disease. At pathologic analysis, ccpRCC was more likely to have low Fuhrman grade, stage T1, no renal vein involvement, no lymphovascular invasion, no sarcomatoid features and no necrosis. ccpRCC subtype is more often associated with African American race, history of chronic renal disease, and more likely to present as an incidental finding.

CONCLUSION

ccpRCC is a newly recognized subtype of RCC that is an indolent tumor with low malignant potential. It has imaging features of both ccRCC and pRCC and ccpRCC may potentially be characterized on preoperative imaging on the basis of tumor composition and enhancement patterns.

CLINICAL RELEVANCE/APPLICATION

ccpRCC is a newly recognized subtype of RCC with low malignant potential and may warrant nephron sparing surgery if accurately characterized on preoperative imaging.

SSC06-08 Correlation of Qualitative Enhancement Features on Multiphasic MDCT with CAIX Expression in Patients with Clear Cell Renal Cell Carcinoma to Predict Prognosis

Monday, Nov. 27 11:40AM - 11:50AM Room: N230B

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PURPOSE

Qualitative assessment of ccRCCs on multiphasic MDCT images may have potentially predictive information about tumor behavior and influence patient management. Low carbonic anhydrase IX (CAIX) expression has been identified as predictor of poorer oncological outcome in patients with ccRCC, but requires additional expense and subspecialty expertise. The primary objective of

our study was to determine which MDCT qualitative imaging features correlate with CAIX expression in patients with ccRCC.

METHOD AND MATERIALS

With IRB approval for this HIPAA-compliant retrospective study, our pathology and imaging databases were queried to obtain a cohort of ccRCC with preoperative multiphasic multidetector CT imaged with a four-phase renal mass protocol (unenhanced (U), corticomedullary (C), nephrographic (N), excretory (E)). CT examinations were reviewed independently by two abdominal fellowship-trained genitourinary radiologists. Each lesion was evaluated for enhancement pattern; presence of necrosis; pattern of; tumor margin; tumor-parenchymal interface, tumor-parenchymal interaction; intratumoral vascularity; collecting system infiltration; renal vein invasion; and calcification. Immunohistochemistry was performed on the resected specimens to assess the degree of CAIX expression. Comparisons between variables included chi-square, kappa and McNemar's test. P values less than 0.05 were considered to be significant. Inter-reader agreement was obtained with the Gwet agreement coefficient (AC1). Multivariate analysis was performed to find independent predictors of low CAIX expression.

RESULTS

We analyzed 108 patients (81 (64%) men and 46 (36%) women) with 108 ccRCC lesions (53 low CAIX and 55 high CAIX). Overall agreement between the two readers had a mean AC1 of 0.8172 (SE 0.0235). Low CAIX expression was significantly associated with the presence of necrosis (odds ratio=2.696, 95% CI=1.034-7.032, p=.038). ROC analysis showed an AUC of .621 (95% CI=.488-.754) in predicting low CAIX expression with qualitative assessment of necrosis.

CONCLUSION

Qualitative assessment had high inter reader agreement for determination of necrosis and was a significant independent predictor of low CAIX tumors.

CLINICAL RELEVANCE/APPLICATION

Qualitative assessment of necrosis on CT may help predict potentially prognostic tumor microenvironment information such as CAIX expression. This may provide a more robust assessment of ccRCC behavior and improve patient outcomes

SSC06-09 Clear Cell RCC Growth Rate Correlates with Degree of Restricted Diffusion in Patients with von Hippel-Lindau Disease

Monday, Nov. 27 11:50AM - 12:00PM Room: N230B

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PURPOSE

To investigate the correlation between growth rate on CT and apparent diffusion coefficient (ADC) in clear cell renal cell cancer (RCC) lesions in patients with von Hippel-Lindau (VHL) disease.

METHOD AND MATERIALS

In this retrospective analysis , 15 patients (6 men and 7 women; mean age, 48 years), with a total of 38 clear cell renal cell lesions, underwent contrast-enhanced CT at two-time points prior to surgery and one pre-operative contrast-enhanced MRI. Volumetric and longest axis diameter (LAD) measurements of the lesions were performed on CT images and growth rates were calculated. ADC values were obtained from pre-operative contrast-enhanced MRIs. Pearson's correlation test was performed to investigate the relationship between ADC values and growth rate based on LAD and volumetric measurements.

RESULTS

The average growth rate was 0.22 cm/year (range: -0.4 to 1.5) based on LAD measurements and 2.9 cc/year (range: -32.1 to 21.9) based on volumetric measurements, with 528 days mean time interval between the two CT scans (range: 67 to 1658). The average ADC value for all lesions was 1.9 χ 10-3 mm2/s (range: 1.1 to 2.6). The average growth rate of each lesion was inversely correlated to ADC value, with a correlation coefficient of -0.39 ($p<0.02$) for growth rate based on volumetric measurements (cc/day), and -0.37($p<0.03$) for growth rate based on LAD measurements (mm/day), suggesting that slower growing lesions demonstrate less restricted diffusion.

CONCLUSION

The degree of restricted diffusion may be a useful measurement in predicting progression of renal lesions in von Hippel-Lindau disease.

CLINICAL RELEVANCE/APPLICATION

The quantification of ADC values should be performed in patients with VHL syndrome undergoing surveillance abdominal MRI.

SSC07

Health Service, Policy and Research (Evidence and Outcomes)

Monday, Nov. 27 10:30AM - 12:00PM Room: S104B

HP RS

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSC07-01 Follow-up of Low-Risk Incidental Findings: Effects of Patient Age and Comorbidity Level on Projected Life Expectancy Benefits

Monday, Nov. 27 10:30AM - 10:40AM Room: S104B

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PURPOSE

To quantify effects of patient age and comorbidity level on life expectancy (LE) benefits associated with routine follow-up of common, low-risk incidental findings.

METHOD AND MATERIALS

We developed a decision-analytic Markov model to project LE benefits associated with imaging follow-up of Bosniak IIF renal cysts and pancreatic side-branch intraductal papillary mucinous neoplasms (SB-IPMNs). Hypothetical cohorts with varied age (60-80 years) and comorbidities (none, mild, moderate, severe) were evaluated. For each finding, we compared LE projections from two strategies: imaging follow-up; and no imaging follow-up. Under follow-up, we assumed that cancers associated with the incidental finding were successfully treated prior to spread. For patients without follow-up, we incorporated mortality risks from Bosniak IIF cysts (renal cell carcinoma) and SB-IPMNs (pancreatic ductal adenocarcinoma). Effects of parameter uncertainty were evaluated in sensitivity analysis.

RESULTS

In the youngest, healthiest cohorts (60-year-olds, no comorbidities), projected LE benefits from follow-up were modest (Bosniak IIF cyst: 7.2 months (women), 6.5 months (men); SB-IPMN: 6.4 months (women), 5.3 months (men)). For follow-up of Bosniak IIF cysts in other cohorts, the LE benefit was 4.3 months in 60-year-old women with severe comorbidities; 3.1 months in 80-year-old women with no comorbidities; and 1.6 months in 80-year-old women with severe comorbidities. Similar trends were observed in men and for SB-IPMN. Results were sensitive to: malignancy risks; and cancer stage at presentation for malignant, unfollowed Bosniak IIF cysts.

CONCLUSION

Follow-up of low-risk incidental findings yields limited benefit for patients with advanced age or severe comorbidities - for such patients, follow-up decisions merit careful consideration.

CLINICAL RELEVANCE/APPLICATION

Modest life expectancy benefits from follow-up of low-risk incidental findings and the variability of benefits by age and comorbidity highlight the importance of patient-centered follow-up decisions.

SSC07-02 Surveillance Imaging for Lung and Colorectal Cancer after Curative Intent Surgery: A Population-Based Study

Monday, Nov. 27 10:40AM - 10:50AM Room: S104B

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PURPOSE

A variety of guidelines exist for surveillance imaging of patients with non small cell lung cancer (NSCLC) and colorectal cancer (CRC) after treatment (Table 1). The purpose of this study was to assess the utilization of high intensity surveillance imaging in Medicare beneficiaries with NSCLC or CRC after curative intent surgery.

METHOD AND MATERIALS

Surveillance imaging utilization was assessed between 2000 and 2013 in >=65 year old fee-for-service Medicare beneficiaries with stage I-IIIA NSCLC or stage I-III CRC registered in a Surveillance, Epidemiology, and End Results (SEER) registry who underwent curative intent surgery. Utilization was defined as the percentage of patients who underwent at least one surveillance examination between 6-18 months after surgery. Independent predictors for use of PET or PET/CT (for which surveillance imaging is not recommended by guidelines) was evaluated using logistic regression analysis.

RESULTS

89,875 curative intent surgical patients (77.6% CRC, 22.4% NSCLC; mean age at diagnosis 76 years; 86% white) were included. Surveillance imaging utilization rates in NSCLC patients were (Table 1): chest CT (69%); brain CT (7%); brain MRI (10%); bone scan (10%); PET or PET/CT (25%). Surveillance imaging utilization rates in CRC patients were (Table 1): chest CT (20%); abdomen and/or pelvis CT (36%); PET or PET/CT (11%). Higher PET or PET/CT utilization was associated with NSCLC vs. CRC (odds ratio [OR] 2.4), younger age (OR 2 for <70; OR 1.9 for 70-74; OR 1.6 for 75-80 when compared to age > 80), white race (OR 1.2 compared with African American), being married (OR 1.1), year of diagnosis after 2005 (OR 2) and geography (OR 1.2 for Southeast when compared to Northeast) (all p values <0.05). Lower utilization of PET or PET/CT was seen in Midwest compared to Northeast (OR 0.8; p<0.05).

CONCLUSION

More than one-third of patients with NSCLC and one-half with CRC undergoing curative intent surgery do not receive guideline recommended post-surgical surveillance imaging. On the other hand, as many as one-quarter undergo PET or PET/CT despite guidelines to the contrary.

CLINICAL RELEVANCE/APPLICATION

Utilization of post-surgical surveillance imaging in Medicare beneficiaries with cancer is frequently guideline discordant.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ruth C. Carlos, MD, MS - 2015 Honored Educator

SSC07-03 Subjective Differences in Solid Tumor Measurements by Radiologists Results in Inconsistent Reporting of Tumor Burden Which Could Adversely Affect Treatment Decisions

Monday, Nov. 27 10:50AM - 11:00AM Room: S104B

Participants
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PURPOSE

Investigate inter-reader variability in measurement of solid tumors. Compare linear measurement/volume to direct volumetric measurement using 3 dimensional(3D) post-processing software.

METHOD AND MATERIALS

For this IRB approved study initial diagnostic CT/MR exams in 100 patients(2mo-20yr) with solid tumors were reviewed by 11

Radiologists and 3 Technologists. Radiologists recorded measurements in 3 axes, described tumor shape (sphere, ellipse, cone) and surface texture (smooth, almost smooth, or mildly, moderately, markedly irregular). 3 Technologists individually, and 3 Radiologists by consensus, used 3D processing software (Intellispace Portal, Philips, Cleveland, OH) to directly measure tumor volume. Inter-reader variability in measurement in all tumors and for tumors divided by surface characteristics were assessed amongst radiologists, technologists, and Radiologist consensus using coefficient of variation(CoV).

RESULTS

Tumor shape was reported as 14 sphere, 84 ellipse, 2 cone, and surface texture as 8 smooth, 10 almost smooth, 32 mildly irregular, 31 moderately irregular,19 markedly irregular. Inter-reader variability of as much as 1,119cc above to 383cc below the mean was found among Radiologist linear measurements, SD 70.3cc, range 0.65-242. Inter-reader variability amongst technologist/radiologist derived volumes was considerably less; SD 14.1cc, range 0.03-98. CoV analysis shows a greater degree of variation in tumor volume calculated from linear measurements than direct volume determination. Variation was significant only for tumor with irregular surface texture [smooth (p=0.26), almost smooth(p=0.23), mildly(p=0.003), moderately(p=0.001), or markedly (p=0.002) irregular].

CONCLUSION

Radiologist generated measurements are subjective, with wide variation. Variation in linear measurement by radiologists affect RESIST, WHO and COG metrics relied on by clinicians but provide only a scalar or innaccurate measure of tumor size. 3D tumor volumetrics are more accurate and reproducible for determining tumor response, may best serve the patient and should become the standard on which to base treatment decisions.

CLINICAL RELEVANCE/APPLICATION

RECIST, WHO, and COG criteria provide only a scalar (RECIST, WHO) or sphere/cylindar volume (COG) measure of tumor burden and should be abandoned due to inherent innaccuracies and misrepresentations of 'accuracy' in reporting tumor size or regression.

SSC07-04 Lumbar Spine MRI: Missed Opportunities for Abdominal Aortic Aneurysm Screening

Monday, Nov. 27 11:00AM - 11:10AM Room: S104B

Participants
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PURPOSE

The U.S. Preventive Services Task Force (USPSTF) recommends one-time sonographic screening for abdominal aortic aneurysms (AAAs) in male smokers ages 65-75 and other selected individuals in this age group based on risk factors. Patients in this age range are frequent utilizers of lumbar spine MRI, in which the abdominal aorta is typically fully imaged. The purpose of this study was to assess the potential utility of lumbar spine MRI performed for other purposes as an alternative mechanism for AAA screening.

METHOD AND MATERIALS

All consecutive lumbar spine MRI exams performed without contrast at a single academic tertiary care center over a one year period (4/1/2016-3/31/2017) in patients ages 65-75 were retrospectively reviewed. Maximal anteroposterior and transverse dimensions of the abdominal aorta were measured using axial T2-weighted images, supplemented with sagittal T2-weighted images if assessment was limited by field-of-view or artifact. The detection rate of AAA, defined as dilation of the aorta to a diameter of >=3 cm, size of AAAs detected, and frequency with which AAAs were reported, were assessed. Differences in aortic diameters and aneurysm detection rates between genders were compared with the unpaired two-sample t-test.

RESULTS

395 lumbar spine MRIs, were reviewed, 240 (60.8%) in women and 155 (39.2%) in men, with mean +/- standard deviation (SD) age of 70.2 +/- 3.2 years. Mean +/- SD maximal abdominal aortic diameter was 2.6 +/- 0.4 cm overall, greater in men (2.7 +/- 0.5 cm), compared to women (2.4 +/- 0.4 cm), p<0.001. AAAs were detected in 38/395 (9.6%) cases, with mean +/- SD size of 3.4 +/- 0.8 cm; 33/38 (86.8%) were >=3 and <4 cm, 3/38 (7.9%) were >=4 and <5.5 cm, and 2/38 (5.3%) were >=5.5 cm. AAAs were more frequent in men (27/155, 17.4%) compared to women (11/240, 4.6%), p<0.001. Of 38 AAAs detected, only 4 (10.5%) were reported by the interpreting radiologist; 3/4 (75%) of which corresponded to aneurysms >=4 cm.

CONCLUSION

Lumbar spine MRI performed in the USPSTF AAA screening age range, especially in men, facilitates detection rates of AAA on par with sonographic screening. However, in typical lumbar spine assessment, AAAs are frequently underreported, particularly for smaller aneurysms.

CLINICAL RELEVANCE/APPLICATION

Routine evaluation of the abdominal aorta on lumbar spine MRI provides a frequently missed opportunity for AAA screening, which may facilitate early management and reduction in duplicative testing.

SSC07-05 Understanding Risk Profiles of Urinary Stone Formers: Lessons Learned from Analysis of CT Scans

Monday, Nov. 27 11:10AM - 11:20AM Room: S104B

Participants
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PURPOSE

Managing covered lives requires knowledge of patient risk profiles. Urinary stone formers have have a higher risk of metabolic abnormalities. We investigated findings associated with metabolic abnormalities detected on unenhanced CT: subcutaneous (SA) and visceral adiposity (VA); bone mineral density (BMD); abdominal aortic calcification (AAC); and hepatic steatosis.

METHOD AND MATERIALS

99 patients with kidney stones who had CT scans and 24-hour urine studies were retrospectively analyzed. BMD and hepatic steatosis were estimated using ROIs within a vertebral body and liver, respectively. VA and SA was estimated using single axial slice area measurements with semi-automated segmentation. AAC and SV were estimated using semi-automated software with Agaston scoring method. Univariate and multivariate linear regression were used to identify associated variables.

RESULTS

Compared to patients with a normal ratio VA to SA, patients with high VA were older (65 vs 51 yrs, p<0.0001), male (70.7% vs 30%, p=0.001), and more likely to have HTN (81% vs 45%, p<0.0001), DM (31% vs 12.5%, p=0.003), CAD (32.8% vs 7.5%, p=0.003), lower BMD (146 vs 168 HU, p<0.0001) and larger SV (256 vs 67 mm3, p=0.009). Compared to patients without AAC, patients with AAC were older (69 vs 44 yr, p<0.0001), had HTN (85% vs 34%, p <0.0001), DM (34% vs 6%, p=0.002), PVD (19% vs 3%, p=0.022), and CAD (34% vs 3%, p <0.001). Compared to patients with normal BMD, patients with low BMD were older (67 vs 50 yr, p<0.0001), male (69% vs 34%, p=0.001), had HTN (81.8% vs 24.7%, p<0.0001), increased VA (251 vs 179 cm2, p=0.003) and larger SV (259 vs 78.4 mm3, p=0.009). Only SV (OR: 1.18; p=0.005) and number of stones were predictive of surgery for stone disease (OR: 1.29; p=0.005).

CONCLUSION

CT exams for stone detection might be used to identify abnormalities that can be integrated into population health risk models and to discover comorbid conditions that may benefit from further evaluation. For example, fewer than 1/3 of older women undergo appropriate screening for low BMD. New detection of decreased BMD could lead to treatment and subsequent fracture risk reduction.

CLINICAL RELEVANCE/APPLICATION

Clinical Relevance Statement: CT exams for stone detection might be used to identify abnormalities that can be integrated into population health risk models and to discover comorbidities that may benefit from further evaluation.

SSC07-06 Impact of MR Surveillance on Long-term Breast Cancer Outcomes in Women with Stage I Primary Breast Cancer: A Microsimulation Model

Monday, Nov. 27 11:20AM - 11:30AM Room: S104B

Participants
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PURPOSE

To project long-term breast cancer (BC) outcomes when adding short-term and long-term magnetic resonance imaging (MRI) surveillance to annual mammography.

METHOD AND MATERIALS

We developed a Markov Monte Carlo microsimulation model of surveillance in women with Stage I BC treated with breast conservation therapy, stratified by age at diagnosis (45, 55, and 65) and primary cancer subtype (Luminal A, Luminal B, HER2+, and Triple Negative). Women in the model face risks of second breast cancers (2BCs), distant metastases, and death due to BC or other causes. Three strategies of annual surveillance until age 75 were compared to no screening (NS): mammography alone (MAM), alternating mammography and MRI at 6-month intervals (MAM/MR), and mammography with alternating MRI for 5 years (MAM/MR5). The model uses a lifetime horizon. Primary outcomes were risk of 2BCs, Life-Years Gained (LYG) and BC death.

RESULTS

Across all ages, women with estrogen receptor (ER) negative cancers (HER2+/ Triple Negative) had the highest risk of 2BCs; the highest incidence was for 45-year-old women with HER2+cancers, with 10-year 2BC incidence of 17.7%. The benefits of surveillance varied substantially by patient age and cancer subtype. The smallest gains were observed in 65-year-old women with Luminal A cancers: per 1,000 women, surveillance resulted in 32 LYG with MAM, 43 LYG with MAM/MR5, and 51 LYG with MAM/MR. BC deaths decreased by 3/1,000 with MAM, 4/1,000 with MAM/MR5, and 5/1,000 with MAM/MR. The largest gains were observed in 45-year-old women with Triple Negative cancers: per 1,000 women, surveillance resulted in 285 LYG with MAM, 365 LYG with MAM/MR5 and 435 LYG with MAM/MR. BC deaths decreased by 13/1,000 with MAM, 16/1,000 with MAM/MR5, and 19/1,000 with MAM/MR. Across all ages in women with ER- subtypes, over half of LYG with MAM/MR were achieved with MAM/MR5.

CONCLUSION

Addition of MRI to mammography for BC surveillance results in modest LYG and BC mortality reduction, which varies by women's age and subtype of primary cancer. For women with ER- cancers who are at highest risk of 2BC, over half of the LYG by adding MR is achieved with surveillance within 5 years of treatment.

CLINICAL RELEVANCE/APPLICATION

Life expectancy gains from post-treatment MR surveillance are modest. In women with ER- cancers, over half of life expectancy gains from MR surveillance are achieved within 5 years after treatment.

SSC07-07 Current Recommended Methods for Calculating Screening Mammography Cancer Detection Rate Systematically Underestimate Performance Compared to Benchmarks

Monday, Nov. 27 11:30AM - 11:40AM Room: S104B

Participants
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PURPOSE

Breast cancer screening benchmarks, like cancer detection rate (CDR), use research databases that achieve near complete outcomes data capture via cancer registries. Clinical practices, however, following BI-RADS and MQSA guidelines use local biopsy results. The purpose of this study is to determine when audits using biopsy lead to a statistically significant underestimation of CDR and potentially inaccurate conclusions about interpretive performance.

METHOD AND MATERIALS

We developed a simulation model that varies practice-level volume and biopsy result ascertainment rate (AR)-i.e. percent of biopsies performed of those recommended-to determine when CDR using biopsy (CDR_Bx) is expected to be statistically significantly different than benchmarks (CDR_Benchmark) from the literature. We varied mammographic volume between 2,000 and 20,000 exams and AR between 40% and 98%. We create a graphical prediction of scenarios when CDR_Bx and CDR_Benchmark will be statistically different using McNemar's test. We then calculated these metrics for our academic practice with both biopsy and registry outcomes. Finally, we overlay average annual National Mammography Database (NMD) performance metrics.

RESULTS

Our simulation demonstrates that scenarios commonly encountered in clinical practice can lead to expected significant differences between CDR_Bx and CDR_Benchmark (Figure). Low AR and high volume predispose to significant CDR underestimation (2 lightest gray areas). Our clinical practice data including 83,895 consecutive screening mammograms (1/1/2006-12/31/2013), reveals an aggregate CDR_Bx of 4.79/1000-statistically significantly inferior to the CDR_Benchmark of 5.1 ($p<0.001$), despite a high AR of 1412/1586 (89.0%) and a registry-based CDR of 5.09/1000. CDR_Bx for 4 of 8 years studied were expected to be significantly below benchmarks. Finally, average annual NMD metrics are at high risk for significant CDR underestimation.

CONCLUSION

Benchmarks for CDR derived with registry outcomes are not directly comparable to practice-level or NMD CDR, which both use biopsy outcomes with limited AR. Significant performance underestimation may result depending on volume and AR.

CLINICAL RELEVANCE/APPLICATION

Because guidelines recommend CDR calculation based on biopsy, comparison to published benchmarks has the potential to systematically underestimate performance and lead to inaccurate quality review.

SSC07-08 Resident Performance in Interpretation of Emergent MRI in Children with Suspected Acute Appendicitis

Monday, Nov. 27 11:40AM - 11:50AM Room: S104B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Ultrasound is currently the initial imaging modality of choice in children with suspected acute appendicitis with cross sectional imaging techniques limited to equivocal ultrasound studies. Of late, MRI has emerged as a more comprehensive imaging technique in many pediatric emergency room with resultant increased demand for residents to gain MR competency in diagnosing acute abdominal conditions. The purpose of this study was to assess on call resident performance in interpreting acute abdominal MRI in children with suspected acute appendicitis.

METHOD AND MATERIALS

Pediatric subjects 18 years or younger, receiving MRI examination as the first imaging assessment in abdominal pain with suspected appendicitis were included in this study. Resident performance was retrospectively analyzed from January 2013 through June 2016 in form of concordance between preliminary interpretation with the final interpretation by an attending. Particular attention was made to the residents' post graduate year (PGY) at the time of interpretation of examination.

RESULTS

Initial evaluation of 150 out of 450 subjects that met the inclusion criteria are presented in this abstract. 123/150 studies were independently evaluated by residents followed by attending overread. Out of the 122 studies, 1 was evaluated by PGY 2 resident while 82, 25 and 14 of the studies were initially evaluated by residents in their PGY 3, 4, and 5, respectively. There was a discordance rate of 9.7% for PGY3 residents, 4% for PGY 4 residents and 0% for residents in PGY5. There was a decrease in rate of discordance with each progressive year with discordance rate of 9%, 9%, 5%, and 0% in years 2013, 2014, 2015 and 2016 respectively. 67 out of 123 patients had a positive finding, 32 (48%) of these children received a diagnosis of acute appendicitis and 30 (94%) of these patients underwent emergent surgical intervention. The average duration of acquiring images was 23 minutes with an average time of 2 hours and 18 minutes till end of scan to interpretation of images.

CONCLUSION

In our facility, resident performance in MR evaluation of acute appendicitis has gradually improved with each progressive academic year from 2013 to 2016 with improved concordance rate seen with increasing post graduate year level.

CLINICAL RELEVANCE/APPLICATION

Resident performance in interpreting acute MRI abdomen during independent has improved with each progressive academic and residents' post graduate year.

SSC07-09 Large-Scale, Observational, Minimal-Risk Hypotheses-Forming Research is Encouraged and Facilitated By Using an Umbrella IRB Protocol with Expedited Intra-Departmental Sub-Study Review and Approval

Monday, Nov. 27 11:50AM - 12:00PM Room: S104B

Participants
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PURPOSE

To demonstrate the safety, feasibility, and effectiveness of an IRB-approved, departmental umbrella protocol designed to facilitate observational clinical imaging research.

METHOD AND MATERIALS

We obtained IRB approval in 2007 for an umbrella protocol that allowed multiple sub-studies and sub-investigators to access and analyze medical records from patients with imaging, prospectively and/or retrospectively. The protocol was overseen by a panel of three senior radiology faculty and an experienced clinical coordinator. Each sub-study required investigator CITI certification, signed agreement to abide by the protocol, a one-page request form, and completion of a feedback questionnaire. A list of projects, adverse events, complaints, and protocol deviations were collected for each sub-study and reported to the IRB annually. The feedback questionnaire responses were summarized descriptively.

RESULTS

Over the past ten years, 106 sub-studies were submitted by 46 unique radiology department personnel for approval by our 3-person radiology panel. Turnaround times for approval varied from one day to one week. Over 105,000 medical records were accessed, 153 abstracts and publications were produced, and the study underwent nine successful annual IRB reviews with no

reports of adverse events, complaints, or protocol deviations. For 22% of sub-studies investigators would not have pursued, and for 23% of sub-studies investigators were unsure whether they would have pursued approval directly from the IRB. Investigators reported that it took an average of 14 minutes to complete the one-page sub-study application form, and they estimated that a full IRB application would have taken them 15.5 hours to complete, with a 4-month time period until study approval. Thus, this protocol may have saved radiology investigators about 1,600 person-hours to complete study requests, and expedited initiation of their studies by over 425 cumulative months (35 years).

CONCLUSION

A responsibly maintained departmental umbrella IRB protocol is safe, feasible, and effective, retaining the benefits of IRB coverage and auditability while facilitating observational clinical research.

CLINICAL RELEVANCE/APPLICATION

Large-scale, observational, minimal-risk hypotheses-forming research is encouraged and facilitated by using an umbrella IRB protocol with expedited intra-departmental sub-study review and approval.

SSC08

Science Session with Keynote: Informatics (Cybersecurity, Analytics, Education and Augmented Reality)

Monday, Nov. 27 10:30AM - 12:00PM Room: S402AB

IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
David J. Harvey, FRCR, Swansea, United Kingdom (*Moderator*) Shareholder, Medical Connections Ltd; Managing Director, Medical Connections Ltd

Sub-Events

SSC08-01 Know Your Enemy: Characteristics of Cyber-Attacks on Medical Imaging Devices

Monday, Nov. 27 10:30AM - 10:40AM Room: S402AB

Participants
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PURPOSE

Used extensively in the diagnosis, treatment, and prevention of disease, medical imaging devices (MIDs), such as MRI or CT machines, play an important role in medicine today. MIDs are increasingly connected to hospital networks, making them vulnerable to sophisticated cyber-attacks targeting the devices' infrastructure and components, which can disrupt digital patient records, and potentially jeopardize patient health. Attacks on MIDs are likely to increase, as attackers' skills improve and the number of unpatched devices with known vulnerabilities that can be easily exploited grows. Attackers may also block access to MIDs or disable them, as part of ransomware attacks, which have been shown to be successful against hospitals.

METHOD AND MATERIALS

We conducted a comprehensive risk analysis survey, based on the Confidentiality, Integrity, and Availability (CIA) model, in collaboration with our country's largest health maintenance organization, to define the characteristics of cyber-attacks on MIDs. The survey included a range of vulnerabilities and potential attacks aimed at MIDs, medical and imaging information systems, and medical protocols and standards such as DICOM and HL7.

RESULTS

Based on our survey, we found that CT devices face the greatest risk of cyber-attack, due to their pivotal role in acute care imaging. Thus, we identified several possible attack vectors that target the infrastructure and functionality of CT devices, which can cause: 1. disruption of the parameters' values used in the scanning protocols within the CT device (e.g., tampering with the radiation exposure levels); 2. mechanical disruption of the CT device (e.g., changing the pitch); 3. disruption of the tomography scan signals constructing the digital images; and 4. denial-of-service attacks against the CT device.

CONCLUSION

Cyber-attacks on MIDs will become a major challenge to device manufacturers and healthcare providers. To ensure a safe healthcare environment and protect patients, users must be aware of the risks and understand the mechanisms behind these potential attacks.

CLINICAL RELEVANCE/APPLICATION

New approaches for detection and prevention, such as we propose to develop, should be deployed and implemented.

SSC08-02 Radiology Cybersecurity: Ratings, Trends, and Challenges

Monday, Nov. 27 10:40AM - 10:50AM Room: S402AB

Participants
Oleg S. Pianykh, Newton Highlands, MA (*Presenter*) Nothing to Disclose

PURPOSE

81% of healthcare organizations have been compromised by cyber-attacks in past 2 years. we believe that it is our principal

approach to securing medical records that has been remarkably passive and outdated. The main purpose of our work was to employ a "big data" analysis to reveal the most recent trends in radiology information security.

METHOD AND MATERIALS

DICOM handshake protocol was used to develop a fast, parallel-processing security-probing application. Testing each IP address for its openness to transmit medical data (with no actual data transferred), the application scanned the entire worldwide space of IP addresses in 4 weeks. Geolocation services were used to map each unsecure IP identified. Thus, we compiled a complete map of open DICOM/HL7 servers worldwide, with different levels of security threats. A comprehensive analysis of this data revealed some major trends in radiology security breaches.

RESULTS

At each run, our scans discovered nearly 3000 DICOM (PACS) servers worldwide, which were left open for external data access. DICOM protocol was used to categorize our findings by different levels of security threats, and geolocation data - by countries and regions. Thus, we compiled DICOM security ratings per country, per capita, and per IT infrastructure. We investigated these ratings for the past three years. Finally, we identified the most prevailing patterns of security breaches, such as cloud servers.

CONCLUSION

Medical cybersecurity should be never treated as static, declarative, or given by default. It cannot be provided by upgraded standards or regulations alone. Medical imaging archives, left wide-open to DICOM and HL7 threats, is by far the most common security problem, which needs to be addressed with a robust, standardized, and fully implemented solution. Our results demonstrate the full scope of this problem, and the areas where it needs to be addressed. The fact that radiology security is not improving over the past years is particularly alarming, and should be addressed by the clinical community.

CLINICAL RELEVANCE/APPLICATION

Our methodology helps identify and prevent hospital security breaches before they happen.

SSC08-03 Service Design and Validation of the Territory-Wide Medical Image Exchange in Hong Kong

Monday, Nov. 27 10:50AM - 11:00AM Room: S402AB

Participants
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CONCLUSION

The project team has developed a novel service design for the implementation of an XDS-Ib based medical image exchange, tailored specifically for the healthcare environment of the territory of Hong Kong. The novel areas include the design options, the Flexible-Hybrid deployment model and validation using an objective tool.

Background

Hong Kong's eHR is a government led centralized HIE. The project team proposes a technical design of a medical image exchange for the eHR and validation. Business requirement, concerns and issues collection was done. A service design proposal was published in 3/2017. The project team proposes a grid architecture using IHE XDS-Ib profiles. Validation was performed using an objective method.

Evaluation

Among private and public, services and technical readiness varied considerably, with high patient flow between sectors. They needed technical support, data privacy/security assurance and clear guidelines on data management. Functions were; upload and validation; viewing and manipulation, via the eHR; future Image download Proposed architecture followed IHE XDS-Ib with 3 parts 1. Digital image and uploading through a DICOM Receiving Gateway 2. Validate, store and distribute by an Image Registry and Repository 3. View in an HTML5 image browser through the eHR portal Design options were identified • functional location of the Gateway • access to local archives • compression level for archival • timing for upload to centralized archives A "flexible-hybrid" approach was proposed. HCPs would be assigned to using centralized archival or distributed archival depending upon their level of technical readiness and other factors. This approach should be most able to fully leverage the advantages of both these modes.

Discussion

Assessment of the design and logic used a tool for project evaluation in the context of an evaluation of a project which is developed for the purpose of societal benefit. Comparison looked for congruence with research literature and international experience of projects with similar concepts. analysis of the service gap literature review for benefits review 13 national scale projects.

SSC08-04 A Tale of Two Protocols: An Honest Assessment of the Impact of an Extended Coverage Protocol on Discrepancy between Preliminary Trainee and Final Staff Reports

Monday, Nov. 27 11:00AM - 11:10AM Room: S402AB

Participants
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CONCLUSION

In light of these findings, institutions should balance the benefits of EC with the cost to trainee education.

Background

In traditional radiology programs, residents provide the requesting physician with an initial report on each study, to be reviewed by the attending radiologist, who provides a final report. Recently, hospitals have been turning to extended staff coverage (EC) models in order to lower the turnaround time to final report and improve patient care. However, the literature suggests that this staff presence may limit resident learning. This study aims to assess the utility of EC by comparing the rate of discrepant reports before and after implementing EC.

Evaluation

7,924 neuroradiology studies were reviewed in total, 5,667 under the initial model and 2,257 under the EC model. Manual report comparison was performed to determine concordance between the preliminary resident and final staff report. For discrepant reports, electronic medical records were reviewed and discrepancies were identified as major (MaD) in the presence of realized impact on patient care or clinical outcome. Cross-tabs and binomial logistic regression were used to investigate the effect of postgraduate year (PGY), study type, presence of significant findings, hour of initial read, priority, inpatient status, patient sex, and history of trauma.

Discussion

Although total discrepancy was lower with implementation of EC (8.2% vs. 7.6% EC), the rate of MaD was higher (1.2% vs. 1.6% EC). Average time from preliminary to final report decreased significantly from 12.2 hours under the previous model to 7.1 hours under EC. Rates of minor and major discrepancy under both models were found to vary significantly with study type, significant findings, and PGY. Previously, discrepancy was also found to be related to the hour of initial read and patient status, while these were not significant under the EC model. Despite the additional coverage, the average number of studies interpreted by the on-call resident per shift did not significantly change (18.6 vs. 19.1 EC). Thus, while the impact of certain variables on discordance was reduced with EC, the overall rate of major discrepancy did not improve with the implementation of EC.

SSC08-05 Educational Value of Pocket-Sized Ultrasound Devices to Improve Understanding of Ultrasound Examination Principles and Sonographic Anatomy for Medical Student

Monday, Nov. 27 11:10AM - 11:20AM Room: S402AB

Participants
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In Seon Lee, MD, Incheon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

It is important that medical students understand the principles of ultrasound (US) examination, because US is an important component of patient care in clinical practice. Hand-held ultrasonography has benefits for its accessibility and easy to use characteristics. The primary objective was to evaluate the educational value of hand-held US to improve interest and understanding of US examinations for medical students.

METHOD AND MATERIALS

We added a US training session comprised of a self-study learning module and a hands-on training session, to a two-week block curriculum of medical imaging for first year medical students using multiple units hand-held US on a small-group basis during a single afternoon. The forty students recruited completed a questionnaire before and after US training; these questionnaires contained 6 and 10 questions, respectively, which were rated using a five-point Likert scale. In addition, the understanding of sonographic anatomy was tested before and after the training program.

RESULTS

All 40 students completed the questionnaires and anatomy-related tests. Students found the program educationally valuable (4.37 of 5) and reported that US practice was useful for improving understanding of the principles of US examination (4.23 of 5) and sonographic anatomy (4.40 of 5). Overall confidence for performing US examinations and understanding of sonographic anatomy were significantly increased after US training (increased overall confidence score, 1.87±0.91, $P < 0.01$, and improved score regarding sonographic anatomy, 6.55±1.55, $P < 0.001$).

CONCLUSION

US training using hand-held ultrasonography is educationally valuable in terms of improving medical student interest in and understanding of US examinations.

CLINICAL RELEVANCE/APPLICATION

US training using portable pocket-sized ultrasound devices are educationally valuable for medical students. Self-study learning module and multiple pocket-sized ultrasound devices enables time-effective and iterative small-group based training.

SSC08-06 RADSVRx (Radiology Advanced eDucational System with Virtual Reality eXperience): Development and Assessment of Diagnostic Skills Through a Virtual and Augmented Reality Educational Platform

Monday, Nov. 27 11:20AM - 11:30AM Room: S402AB

Participants
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PURPOSE

To design an online and mobile VR/AR platform for radiology education, and 1) explore the potential of VR/AR in radiology education; 2) Understand the integration and limitations of VR/AR into radiology education; 3) measure user learning outcomes and feedback.

METHOD AND MATERIALS

We designed an online/mobile open access virtual and augmented reality platform for radiology education and its use with a head mount/VR viewer for a mobile phone compatible with android or iOS. The content was divided in 4 anatomical models (neuroimaging, cardiology, msk and IR) , 4 clinical cases and a virtual working station. During the annual meeting at the RSNA 2016 we invited to test the platform to 180 Participants (Medical students, residents, fellows and radiologists) to complete a survey to measure change in confidence and performance on normal/pathologic cases to assess learning. The post survey also assessed users attitudes toward the VR learning environment.

RESULTS

Of the 180 participants, 130 rated the course experience, pre-post confidence surveys, and pre-post cases. On a Seven-point Likert scale (1: strongly disagree to 7: strongly agree), participants mean reported confidence increased from pre to post VR/AR exposure with respect to: identify normal structures on a traditional CT/MRI scan (pre= 5.0 to post = 6.2, p= 0.02); identifying abnormalities on a traditional CT/MRI scan (pre = 5.3 to post= 6.4, p=0.02) On the clinical cases, the percentage of users giving a correct diagnosis increased from 64.6% (84 of 130) pre to 86.1% (112 of 130) post (p=0.2). Most participants agreed that VR/AR is an effective method for radiology education especially for medical students or radiology residency, and only 2.3% (3 of 130) disagreed with the statement that this is a potential tool that can benefit the traditional teaching method. 40% commented that VR support radiologist to integrate, educate and inform patients about their imaging studies.

CONCLUSION

The results on this pilot suggest a potential benefit in the integration of virtual reality to the traditional radiology education models, contributing to more immersive radiology educational experiences.

CLINICAL RELEVANCE/APPLICATION

VR/AR application to the traditional radiology education gives the opportunity to integrate high impact technology to a very low cost, increasing the accessibility and cost-effectiveness.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Tatiana Kelil, MD - 2017 Honored Educator

SSC08-07 Can a Pay-For-Performance Approach Help to Increase Patients' Satisfaction?

Monday, Nov. 27 11:30AM - 11:40AM Room: S402AB

Participants
Achim Escher, Basel, Switzerland (*Presenter*) Nothing to Disclose
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Georg M. Bongartz, MD, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose
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CONCLUSION

Combining a continuous evaluation of patient's satisfaction with its outcome linked to a P4P bonus payment led to a significant increase in patient's satisfaction.

Background

To improve patients' satisfaction, a Pay-for-Performance (P4P) approach for technicians and frontdesk employees was implemented. Patients' satisfaction was measured with an electronic device allowing patients to give feedback about their overall experience by pressing a button on a color coded 4-level score from "very positive" to "very negative". Collected data was used to calculate a "satisfaction index" (SI). A bonus payment was based on the results of the SI. Depending on it each day a bonus of 5 Swiss Francs (CHF) (SI>95%) or CHF 10 (SI=100%) was awarded by the employees. Results of the survey and the cumulated bonus were frequently presented at the employee's whiteboard.

Evaluation

Measuring patients' satisfaction permanently started in 6/2016. The main key performance indicator was the SI which is a weighted measure of the four categories. The goal was to reach a minimum SI of 95%. Comparing the period 6/2016 - 11/2016 to the period from 12/2016 - 03/2016 the mean SI increased from 92.7% to 95.5%. "Very negative" feedback dropped from 1.8% to 1.1%. Positive feedback (sum of "positive" and "very positive") increased from 95.5% to 98.5%. The mean bonus payment per month increased from CHF 66.00 to CHF 103.75

Discussion

Measuring patients' satisfaction is indispensable to gain insight in patients' overall experience. Patient satisfaction is usually measured via questionnaires with a poor return ratio and consecutively unreliable results. Our approach uses an electronic device that allows patients to provide feedback within a second by pressing one out of four buttons. This eliminates the disadvantage of time-consuming questionnaires. However, the unidimensional data structure does not provide qualitative information. Using a novel P4P approach led to some resistance within the staff. However, the acceptance of this kind of motivational approach increased as soon as employees understood that they will receive a significant gratification at the end of the year.

SSC08-08 Contrast Emergency Management Training Using an Immersive Virtual Reality (VR) Headset: A Feasibility Pilot

Monday, Nov. 27 11:40AM - 11:50AM Room: S402AB

Participants
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PURPOSE

A simulation curriculum for contrast and emergency management has been established in our department, based at a large medical school-affiliated hospital. The annual training requires approximately two hours in a simulation laboratory, where nurses, technologists and physicians partake in simulation exercises. We developed a simulation platform for a VR headset using recorded immersive video content, and performed a pilot study to evaluate the feasibility of incorporating the technology into our existing simulation program.

METHOD AND MATERIALS

A scripted contrast emergency (severe anaphylactoid reaction) was recorded using a 360-degree camera rig and 7 high-resolution cameras (GoPro Inc). Actors were used to play the physician, technologist and nurse during the management of a simulated patient. A high-fidelity mannequin (SimMan 3G) was used during the case, and the mannequin's vital signs, behavior and voice were controlled by an instructor. A Dynamic Medical Immersive Training Environment (DynaMITE) was used to display the content on a VR headset (Samsung Gear VR). All participants undertook a feedback survey before and after viewing the immersive training content, which included questions on a Likert scale about usability and side effects.

RESULTS

19 staff members agreed to participate in the pilot study, including nurses, technologists and physicians. 16 participants had previously attending an in-person contrast simulation. The majority (n = 12) had not used a VR headset before. When asked if they thought the VR headset had a role in training physicians, 14 answered yes and the remaining 5 participants answered "maybe". 3 of the 19 participants reported dizziness / nausea when wearing the headset, and the majority of users believed the image quality to be high. 7 people believed that contrast simulation using a VR headset could replace in-person training at the simulation lab, and 8 people believed it would be complementary to the existing training.

CONCLUSION

In-person training requires presence at a simulation center for 2 hours, and immersive simulation using a VR headset may be useful as an adjunct to existing radiology emergency simulations, particularly at off-site imaging centers without access to a high-fidelity mannequin.

CLINICAL RELEVANCE/APPLICATION

Immersive content, delivered on a head-mounted VR display, may allow for an expansion of existing simulation training.

SSC08-09 Informatics Keynote Speaker: Cybersecurity in Radiology

Monday, Nov. 27 11:50AM - 12:00PM Room: S402AB

Participants
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ABSTRACT

There are many aspects to cybersecurity in radiology, and it is important to look beyond the problems posed by the traditional data stealing "hacker" to wider threats against the confidentiality, availability and integrity of the data held by radiology departments. There has been widespread coverage of data theft from many organisations, and institutions have taken measures to protect their patients' privacy, but other threats that must also be considered include those against availability (such as ransomware) and even potentially those which could deliberately insert false and damaging data into radiology systems. Most of the computer systems in a radiology department communicate via DICOM and HL7, which were developed decades ago, before such threats were considered, and special consideration should be given to mitigation of the weaknesses and opportunities that they present to adversaries.

SSC09

Musculoskeletal (Metabolic, Functional and Quantitative)

Monday, Nov. 27 10:30AM - 12:00PM Room: E450B

BQ CT MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Gregory Chang, MD, New York, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSC09-01 Low Paraspinous Muscle Attenuation on Computed Tomography (CT) Predicts All-cause Mortality in the National Lung Screening Trial

Monday, Nov. 27 10:30AM - 10:40AM Room: E450B

Participants
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PURPOSE

To examine the association between paraspinous muscle CT attenuation at baseline and at year-2 follow-up with all-cause mortality over 6 years in older men and women in the National Lung Screening Trial (NLST).

METHOD AND MATERIALS

Association of muscle attenuation and all-cause mortality was examined in 1176 men and 672 women, age 70-74 years, from the CT arm of the NLST. Analysis of low-dose chest CTs at baseline and year-2 follow-up was performed. Using a clinical PACS workstation (iSite version 3.6, Philips Healthcare), left paraspinous muscles were segmented at the level of T12 vertebra. Associations between baseline muscle attenuation and change in muscle attenuation with all-cause mortality were determined using logistic regression models. Four models were used, stratified by sex: 1) unadjusted; 2) adjusted for age, race and BMI; 3) Model 2 plus smoking; 4) Model 3 plus chronic conditions (cancer, COPD, emphysema, hypertension, heart disease, stroke).

RESULTS

At a mean 6 years of follow-up, 201 (17.1%) men and 81 (12.1%) women were deceased. In men, mean (SD) paraspinous muscle attenuation was 37.0HU (10.9) at baseline and 35.7HU (12.5) at year-2. In women, mean (SD) paraspinous muscle attenuation was 32.3HU (11.4) at baseline and 31.6HU (11.8) at year-2. In men, baseline muscle attenuation was inversely associated with all-cause mortality in all 4 models (Model 4: OR = 0.85; CI = 0.72, 0.99; p=0.04). In women, the association did not reach significance (Model 4: OR = 0.95; CI = 0.73, 1.23; p=0.70). In men and women, the change in muscle attenuation from baseline to year-2 was not associated with mortality.

CONCLUSION

In older men but not women, decreased paraspinous muscle attenuation, indicative of increased fatty infiltration, was associated with increased all-cause mortality. Two-year change in muscle attenuation was not associated with mortality.

CLINICAL RELEVANCE/APPLICATION

Opportunistic measurement of muscle attenuation on chest CT examinations may help improve the accuracy of health-related outcome prediction models in older adults.

SSC09-02 Opportunistic Utility of Appraising BMD via RADIOMICS (Texture Analysis and Data Mining) of Proximal Femur and L-1 Vertebra on routine CT Abdomen and Pelvis

Monday, Nov. 27 10:40AM - 10:50AM Room: E450B

Participants
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PURPOSE

Introduction: Osteoporosis remains substantially underdiagnosed, furthermore, more than 80% of pts with osteoporosis-related fractures have never had BMD testing. Though QCT is fairly accurate, it is not routinely used. Recently textural analysis (TEX) and data mining (DATmin) i.e. RADIOMICS has emerged as a promising endeavor in medical imaging. We have assessed the utility of supervised DATmin a panel of TEX features extracted from CT abdomen and pelvis (CTAP).

METHOD AND MATERIALS

Retrospective review of a unique cohort of pts. [females=17, age= 51.7 (36-74) yrs.] with breast Ca. undergoing concurrent CTAP and BMD (LUNAR, GE, Waukesha). All scans were acquired per accepted protocols. For extraction of textures, 2D ROI were drawn on a representative coronal slice, the Rt. Femoral Neck (FNk), Wards triangle (WT), Trochanter (Troc) and L-1 were flagged using BMD as guidance, on a MIMSOFTWARE (Cleveland, OH, USA) review workstation. Images were exported as DICOM-RT, to a home built TEX computing module in MATLAB. A panel of 42 TEX features were computed from each of the ROI. The extracted TEX features were data mined, using supervised classification in WEKA (Univ. of Waikato, New Zealand), the ground truth was class definition by BMD. The following algorithms were evaluated: J48, NaiveBayes, and Random Forest, with both leave one out 10 fold, and split 66:33 as training and validation sets.

RESULTS

Among the three classifiers Naive Bayes was the best classifier, followed by Random Forest and J48. With percent split validation using Naive Bayes, 100% were correctly classified as (nor=4, osteopenia=2) the percent correct vs. incorrect classification for Troc, FNk, and L-1 were 83:17; 67:33; and 33:67 respectively. The ROC for the four ROIs were 100, 73, 63 and 13% respectively.

CONCLUSION

In our series of extracted TEX features from different sites, WT was the most accurate, followed by Troc, FNk and least L-1 using NaiveBayes classifier. Analysis in a larger cohort, as well as incorporating additional algorithms (fractals, wavelets etc) is anticipated to improve test performance.

CLINICAL RELEVANCE/APPLICATION

Data Mining of opportunistically extracted TEX features appears to be a promising screening tool for BMD at no extra cost in pts. undergoing CTAP.

SSC09-03 3T MRI of Proximal Femur Microarchitecture Discriminates between Subjects Without and With Fragility Fractures

Monday, Nov. 27 10:50AM - 11:00AM Room: E450B

Participants
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PURPOSE

To determine if 3T MRI of proximal femur microarchitecture can discriminate between subjects without and with fragility fracture.

METHOD AND MATERIALS

This prospective study had institutional review board approval and was HIPAA compliant. From the Osteoporosis Center at our institution, we recruited 80 subjects without fragility fracture (78 female, 2 males; median age = 61.0 years, interquartile range = 10.0 years; median body mass index = 21.0 kg/m2, interquartile range = 3.8 kg/m2) and 41 subjects with fragility fracture (36 females, 5 males; median age = 63.0 years, interquartile range = 15.3 years; median body mass index = 22.1 kg/m2, interquartile range = 5.9 kg/m2). All subjects underwent 3T MRI of the same hip as scanned by DXA to assess bone microarchitecture. Standard statistical methods were used to assess discriminatory ability of parameters and correlations between total hip BMD and microarchitecture.

RESULTS

Femoral head trabecular plate edges and rods (AUCs=0.610-0.637; CIs=0.507-0.531 to 0.714-0.742), femoral neck trabecular plate edges, rod disruption, and plate-to-rod ratio (AUCs=0.616-0.620, CIs= 0.504-0.509 to 0.726-0.730), Ward's triangle trabecular isolation, plate-to-rod ratio, and plate width (AUCs=0.613-0.649, CIs=0.509-0.543 to 0.718-0.754), and inter-trochanteric bone volume fraction and trabecular isolation, plate edges, rod disruption, number, and separation (AUCs=0.617-0.642, CIs=0.505-0.541 to 0.728-0.743) could discriminate fracture cases from controls. Total hip BMD (AUC=0.480, CI=0.370-0.591) could not discriminate fracture cases from controls. Within the intertrochanteric region only, total hip BMD demonstrated weak correlations with bone volume fraction, trabecular isolation, plate edges, rod disruption, number, and separation (rho = -0.214 to 0.215, $p < 0.05$ for all).

CONCLUSION

3T MRI of proximal femur microarchitecture can discriminate between subjects without and with fragility fracture and may provide added information about fracture risk beyond BMD.

CLINICAL RELEVANCE/APPLICATION

3T MRI of proximal femur microarchitecture discriminates between subjects without and with fragility fractures and therefore may provide better quantitative assessment of bone than DXA scan

SSC09-04 New Dietary Strategies Addressing the Specific Needs of Elderly Population for a Healthy Aging in Europe: The NU-AGE Approach for Ageing, a Link Between Body Composition Assessed by DXA and Inflammation

Monday, Nov. 27 11:00AM - 11:10AM Room: E450B

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PURPOSE

Demographic trends show progressive ageing of the population and increasing incidence of age-related diseases. Current evidence emphasizes the role of low-grade chronic inflammation in the process of ageing, and body composition(BC) has been shown to undergo significant changes with ageing. The aim of the present work is to outline the correlation between fat and lean mass distribution, assessed by dual-energy X-ray absorptiometry(DXA),and inflammatory markers.

METHOD AND MATERIALS

A total of 1295 volunteers free of major overt diseases, ageing 65-79 years, were enrolled in 5 European countries(Italy, France, United Kingdom, Netherlands, and Poland). Whole-body DXA scans to assess BC, and blood samples were taken. BC analysis was focused on 6 pivotal markers: fat mass/lean mass(FM/LM), androidFM/LM, android/gynoidFM, lean mass index(LMI), appendicular lean mass index(ALMI), and skeletal muscle mass index(SMI). Plasma levels of pro-inflammatory markers C-reactive protein(CRP) and leptin, and anti-inflammatory marker adiponectin were assayed.

RESULTS

CRP and leptin levels were found to positively correlate with FM, while negatively with LM. CRP showed weak correlations, while a strong positive correlation($p<2.2e-16$) was observed between leptin levels and FM/LM($r=0.807$), and androidFM/LM($r=0.736$). Leptin negatively correlates with SMI($r=-0.739$) and ALMI($r=-0.280$). Consistently, adiponectin was negatively correlated with android/gynoidFM($r=-0.593$). Surprisingly, adiponectin was positively correlated with the FM/LMratio($r=0.223$) and negatively correlated with LM($r=-0.477,-0475,-0.296$ with ALMI,LMI and SMI, respectively).

CONCLUSION

Assessment of fat and lean mass is essential, and DXA is a gold standard technique. Insights into the pathophysiology of inflammation are provided by BC analysis. Leptin was the inflammatory marker that better correlated with BC markers of FM and central adiposity, while adiponectin showed a negative correlation with android adiposity, reinforcing the protective role of gynoid distribution in metabolism. Discordance between adiponectin levels and BC "protective factors"should be further addressed to understand their differential role in inflammation and metabolism modulation.

CLINICAL RELEVANCE/APPLICATION

DXA BC parameters correlate with plasma inflammatory markers, and may be useful to obtain a picture of patients' risk status.

SSC09-05 Reproducibility of Trabecular Bone Score and Bone Mineral Density at Different Scan Modes on a Phantom: What Is the Effect of a Fictitious Soft Tissue Increase?

Monday, Nov. 27 11:10AM - 11:20AM Room: E450B

Participants
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PURPOSE

Trabecular Bone Score (TBS) provides an indirect index of trabecular microarchitecture from lumbar spine (LS) dual energy x-ray absorptiometry (DXA). TBS mean values have been reported to be negatively influenced by increasing body mass index (BMI), due to the augmented thickness of superimposed soft tissue. In this phantom study we evaluated the effect of a fictitious increase of soft tissue thickness on TBS and bone mineral density (BMD) reproducibility (REP).

METHOD AND MATERIALS

An Hologic spine phantom was scanned with a QDR-Discovery W Hologic densitometer. Fresh pork rind layers of 5mm were used to simulate the in-vivo soft tissues. For each scan mode [fast array (FA), array, high definition (HD)] 25 scans were consecutively performed, without phantom repositioning, at 0 (no layers), 1 and 3cm of thickness. The coefficient of variation (CoV) was calculated as the ratio between standard deviation and mean; percent least significant change (LSC%) as 2.77×CoV; REP as the complement to 100%of LSC%. BMD unit: g/cm2, TBS is unitless. Data are provided as mean ± standard deviation.

RESULTS

Considering the three scan modes, REP ranged at 0-cm between 99.0%-99.4% (BMD) and 98.2%-98.8% (TBS). REP at 3-cm: 98.7%-98.9% (BMD), 97.4-98.2% (TBS). The difference in terms of REP decrease between BMD and TBS was comparable at 0 and 3 cm of soft-tissue thickness (-0,8 at 0 cm, -0,7 at 3 cm). Both BMD and TBS significantly decreased with increasing soft tissue, but the reduction was more pronounced for TBS. The greatest difference for BMD and TBS was found at FA: BMD = 0.987±0.010 (0cm) - 0.980±0,013 (3cm), difference of -0,007 (-0.67%, p<0.001); TBS = 1.420±0.026 (0cm) - 1.337±0.024 (3cm), difference of -0.083 (-6,17%, p<0.001). BMD mean differences between 0-3 cm were always lower than BMD LSC, while TBS mean differences were always higher than TBS LSC.

CONCLUSION

TBS REP was overall lower compared to BMD REP. There was a comparable decrease between BMD REP and TBS REP whit increasing soft-tissue layers. Both BMD and TBS are negatively influenced by increased soft tissue thickness, but only TBS variations exceed the LSC.

CLINICAL RELEVANCE/APPLICATION

For an identical bone quality, TBS may be lower in patients with high BMI values.

SSC09-06 Prediction of Osteoporotic Fractures from Routine CTs Using Large Scale Collectives: Data Handling, Image Analysis and First Clinical Results Derived from Over 250,000 Patients

Monday, Nov. 27 11:20AM - 11:30AM Room: E450B

Participants
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PURPOSE

To evaluate if bone density derived from large scale routinely acquired CTs can be used as predictive marker for osteoporotic fractures and included within a clinical diagnostic routine.

METHOD AND MATERIALS

2,300 patients with osteoporotic fractures were identified from clinical admission data and cross-checked against the PACS database using a new, in house developed software, PACS-Crawler, to identify patients with CT scans performed for other indications. Two groups were identified; group 1 encompassing 954 patients with scans at least three months before fracture, and group 2 comprised of 1223 patients with scans around the time of fracture. The data was anonymized and moved en-masse to a 32 core cluster using the PACS-Crawler software. There, bone extraction was performed using a customized imageJ-based plug-in and density percentiles were automatically extracted. Mean bone density and standard deviation were compared to a normative collective of 250,000 patients using a Mann-Whitney-U test, tests were considered significant at P< 0.05.

RESULTS

There was no significant difference in bone density of patients in group 1 (P=0.36) and 2 (P=0.27) and those without fractures. However, compared separately by anatomical region there was a significantly lower bone density in patients with osteoporotic fracture in comparison with the normal collective in head CTs (P<0.01). This difference was more pronounced in male than in female patients.

CONCLUSION

Although there was no significant difference considering bone density overall, significant differences in bone density between patients with osteoporotic fracture and the normal collective were visible in one of the most frequently performed CT scans, the cranial CT. In the future this analysis will be refined and extended to different anatomical regions and substructures.

CLINICAL RELEVANCE/APPLICATION

In this work, we have established a software pipeline for big data searching, relaying and processing. Our first results show that thus extracted parameters may be relevant and implementable in a clinical context in terms of osteoporotic fracture risk analysis.

SSC09-07 Automated Muscle Analysis Tool (AMAT) for Large Scale CT Image Analytics

Monday, Nov. 27 11:30AM - 11:40AM Room: E450B

Participants
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PURPOSE

To develop and validate an Automated Muscle Analysis Tool (AMAT) for measuring muscle attenuation and cross-sectional area in large CT datasets.

METHOD AND MATERIALS

AMAT was developed using open-source medical image analysis tools: Advanced Normalization Tools (ANTs) and the Oxford Centre for Functional Magnetic Resonance Imaging of the Brain Software Library (FSL). AMAT employs a three-dimensional (3D) stage to identify the level (e.g.T12 vertebra) and a two-dimensional (2D) stage to segment the muscle (e.g. left paraspinous muscle). Both stages involve four main steps: 1) pre-processing, 2) template construction, 3) region of interest labeling, and 4) warping. AMAT was validated in 113 non-contrast chest CT exams (slice thickness 0.625-2.0 mm) in 73 men and 40 women, age 70-74 years, in the CT arm of the National Lung Screening Trial. For validation, left paraspinous muscle was manually segmented at T12 level, using Mimics software (version 19.0; Materialise, Leuven, Belgium) with muscle thresholds set at -29 to150 HU. For the 3D stage, the accuracy error of AMAT was based on the number of mm between the locations chosen by AMAT and the human reader. For the 2D stage, accuracy was determined by comparing the muscle cross-sectional areas and attenuations derived by AMAT to the values obtained manually.

RESULTS

AMAT development followed an iterative process, where each step was continually improved based on previous trials. Mean (SD) values for paraspinous muscle attenuation were 44.7HU (6.0) for manual and 45.5HU (6.3) for AMAT. Mean (SD) values for paraspinous muscle cross-sectional area were 15.5 cm2 (3.0) for manual and 13.9 cm2 (3.3) for AMAT. For the 3D stage, mean accuracy error was 11.8mm (4%); range: 0.2-44.7mm (0-14%). For the 2D stage, mean accuracy error for muscle attenuation was 1.6HU (4%); range: 0-6.2HU (0-13%). Mean accuracy error for muscle cross-sectional area was 2.0cm2 (13%); range: 0.1-7.8cm2 (0-54%).

CONCLUSION

Initial validation results of AMAT are promising. Iterative correction of deficient procedures will continue to improve the accuracy of AMAT.

CLINICAL RELEVANCE/APPLICATION

Current CT image analysis of muscle cross-sectional area and attenuation requires time consuming manual segmentation. AMAT will allow for automated large-scale analytics of muscle metrics on CT examinations that could be adapted to other muscle groups and body regions including abdomen, pelvis, and extremities.

SSC09-08 Sex Differences in Body Composition and Association with Cardiometabolic Risk

Monday, Nov. 27 11:40AM - 11:50AM Room: E450B

Participants
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PURPOSE

Body composition differs between men and women, with women having proportionally more fat and men more muscle mass. Fat distribution is an important determinant of cardiometabolic risk, with certain ectopic fat depots [visceral adipose tissue (VAT), intramyocellular (IMCL) and intrahepatic lipids (IHL)] being more detrimental than others [femorogluteal subcutaneous adipose tissue (SAT)]. We hypothesized that there are sex-differences in body composition and ectopic fat depots and that these are associated with a sex-specific cardiometabolic risk profile.

METHOD AND MATERIALS

Our study was IRB-approved and HIPAA compliant. Written informed consent was obtained. We recruited 200 young, non-diabetic, overweight and obese subjects who were otherwise healthy (109 women, 91 men, mean age: 37±10 years, mean BMI: 35.2±5.8 kg/m2). After an overnight fast, subjects underwent DXA and CT for body composition, 1H-MRS at 3T of soleus muscle for IMCL and right hepatic lobe for IHL quantification, serum glucose, insulin and lipids. Men and women were compared by ANOVA. Linear regression analyses between body composition measures and cardiometabolic risk markers were performed.

RESULTS

Women and men were of similar age and BMI (p=0.4). Women had higher %fat mass by DXA and lower lean mass vs men (p<0.0001). However, men had more VAT and VAT/abdominal SAT, muscle mass (p<0.0001), IMCL (p=0.0008) and IHL (p=0.005), while women had more femoral SAT (p<0.0001). Compared to women, men had higher measures of cardiometabolic risk, including serum triglycerides, apolipoprotein B, fasting insulin and HOMA-IR (p<=0.005). However, in women, VAT, IMCL, and IHL were strongly associated with these measures of cardiometabolic risk (p<=0.004), while in men these associations were weaker or non-significant.

CONCLUSION

Obese men have relatively higher VAT, IMCL, IHL, muscle and lean mass, while obese women have more %fat mass and femoral SAT. This female anthropometric phenotype is associated with a better cardiometabolic risk profile at a similar BMI compared to men. However, ectopic fat is more strongly associated with adverse cardiometabolic risk factors in women compared to men.

CLINICAL RELEVANCE/APPLICATION

The female pattern of fat distribution is associated with improved cardiometabolic risk compared to men at similar BMI, while ectopic fat in women portends greater metabolic risk.

SSC09-09 Sarcopenic Obesity and Cardiometabolic Risk in Young Adults with Obesity

Monday, Nov. 27 11:50AM - 12:00PM Room: E450B

Participants
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PURPOSE

Sarcopenic obesity, reduced skeletal muscle mass in the setting of obesity, is an important risk factor for cardiometabolic disease in the elderly, but it is unknown whether relatively lower skeletal muscle mass for BMI in young adults, i.e. relative sarcopenia, contributes to cardiometabolic risk. We hypothesized that relative sarcopenia is associated with cardiometabolic risk markers in young adults with obesity.

METHOD AND MATERIALS

Our study was IRB-approved and HIPAA compliant. Written informed consent was obtained. We recruited 188 young overweight and obese subjects who were otherwise healthy, including without diabetes mellitus (100 women, 88 men, mean age: 36.8±9 years, mean BMI: 35.0±5.7 kg/m2). All subjects underwent DXA and CT for body composition, an oral glucose tolerance test (OGTT), fasting serum insulin, lipids and inflammatory markers. DXA appendicular lean mass (ALM)/BMI was used as a measure of relative sarcopenia and subjects were divided by the ALM/BMI median. Groups were compared by ANOVA.

RESULTS

Women with lower ALM/BMI (relative sarcopenia) had a higher mean 120-min glucose level (p=0.02) and higher glucose area under the curve on OGTT (p=0.003), lower HDL cholesterol (p=0.02), higher apolipoproteinB (ApoB) and ApoB/LDL (p=0.02), higher hsCRP (p=0.005) and fibrinogen (p<0.0001) and lower muscle attenuation, suggestive of fatty infiltration (p=0.003) compared to women with higher ALM/BMI, despite similar age (p=0.7) and weight (p=0.5). Men with lower ALM/BMI had higher mean insulin (p=0.001), HOMA-IR (p=0.003), hsCRP (p=0.008) and fibrinogen (p=0.007), and lower muscle attenuation (p=0.006) compared to men with higher ALM/BMI, despite similar age (p=0.6) and weight (p=0.4).

CONCLUSION

Relative sarcopenia (lower ALM/BMI) is associated with measures of cardiometabolic risk in young adults with obesity, and these effects are stronger in women than in men. Our study suggests that relative sarcopenia may be an under-appreciated mechanism linking obesity to cardiometabolic risk, and prospective studies are needed to determine whether relative sarcopenia predicts incident cardiometabolic disease over time.

CLINICAL RELEVANCE/APPLICATION

Relative sarcopenia may be an under-appreciated mechanism linking obesity to cardiometabolic risk in young adults with obesity, a high-risk group for developing cardiometabolic disease.

SSC10

Nuclear Medicine (Pulmonary and Cardiovascular Imaging)

Monday, Nov. 27 10:30AM - 12:00PM Room: S505AB

CH CT NM VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSC10-01 Improved Pulmonary Nodule Detection Using a Next Generation 18F-FDG PET Imaging System

Monday, Nov. 27 10:30AM - 10:40AM Room: S505AB

Participants
Sonya Y. Park, MD, Stanford, CA (*Presenter*) Nothing to Disclose
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PURPOSE

One diagnostic indication for FDG PET is to determine whether a pulmonary nodule is benign or malignant based on the uptake of the nodule. However, FDG PET is limited by a relatively low spatial resolution (5 mm) that can lead to underestimation of tracer uptake and detectability in small lesions. The objective of this study was to evaluate the detection rate for pulmonary nodules using a next generation digital PET/CT system using Silicon Photomuliplier (SiPM) technology for increased contrast recovery and lower background variability in patients with known malignancies.

METHOD AND MATERIALS

76 consecutively enrolled patients who were referred for cancer staging by 18F-FDG PET/CT underwent scans on the standard of care (SoC) and new digital system (Discovery Meaningful Insights) from September-December 2016. Images from the SoC PET/CT were reconstructed using time-of-flight (ToF) and ordered subset expectation maximization (OSEM) protocols. Images from digital PET/CT were reconstructed using ToF and a Bayesian penalized likelihood algorithm. Two experienced, nuclear medicine trained readers reviewed both scans for each patient in random order, blinded to clinical information and recorded the location and standardized uptake value (SUV) measurement for each nodule. Differences in acquisition protocols were measured based on the distribution of the analyzed data and difference in detection rates assessed by McNemar's test.

RESULTS

Excluding one patient who had innumerable metastatic nodules on both scans, the number of lesions detected on the digital and standard of care PET/CT were 35 and 20, respectively. Of the 57 patients with negative standard of care scans, 7 (12%) demonstrated FDG-avid pulmonary nodules on the digital PET/CT. More lesions were detected on digital PET/CT in four patients who had nodules identified by both methods. Detection rates remained the same for 65/76 patients (86%), including 51 who were negative on both scans. Digital PET/CT nodules had a higher SUVmax compared to the standard of care (2.0; IQR 0.9-6.0 versus 1.3; 0.6-3.9, $p < 0.001$).

CONCLUSION

Digital PET/CT system detects more FDG avid pulmonary nodules. FDG PET for diagnosing pulmonary nodules and staging metastatic disease to the lungs will require re-evaluation with this new, more sensitive platform.

CLINICAL RELEVANCE/APPLICATION

The new digital PET/CT system can provide higher resolution, and is recommended for the detection of pulmonary nodules.

SSC10-02 Estimating Lung Carbon Monoxide Diffusion Rates with Positron Emission Tomography

Monday, Nov. 27 10:40AM - 10:50AM Room: S505AB

Participants
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PURPOSE

Regional assessments of gas exchange could be highly useful for assessing the efficacy vascular-targeted treatment responses in pulmonary arterial hypertension. We performed a pilot study in healthy volunteers to determine whether carbon monoxide (CO) transfer in the lungs could be estimated with 15O-CO positron emission tomography (PET).

METHOD AND MATERIALS

Healthy volunteers were imaged twice in a Siemens Biograph 40 PET/CT scanner. After fully emptying their lungs, volunteers sharply inhaled 20-40 mCi of 15O-CO to maximal inspiration, held their breath for a minimum of 10 seconds, then exhaled during a 7-min dynamic scan acquisition starting at ~30 sec prior to inhalation. End-expiration CT scans were obtained for attenuation correction. From first principles, it is straightforward to show that the logarithmic time-derivative of the alveolar CO concentration is proportional to the pulmonary function testing (PFT) lab-estimated CO transfer rate, KCO, during breath hold. We estimated the maximum total rate of CO transfer from the whole-lung image region as the logarithmic derivative at the inflection point after the peak (image-region clearance rate, IRCR). We input the IRCR with the peak and steady-state CO concentrations as predictors controlling for inter-patient inhalation differences into a multiple linear regression model with the PFT values as the response. Intraclass correlation coefficients (ICC) and Bland-Altman analysis characterized correlation and reproducibility.

RESULTS

Nine healthy volunteers completed the study procedures. One volunteer with a very high KCO (43% above reference values) was excluded so as not to overly influence the regression model. The IRCR was highly correlated with the KCO by Bland-Altman analysis. ICCs were 0.99 and 0.92 for Scan 1 and Scan 2 IRCR values, respectively, vs KCO. The reproducibility of the IRCR was also high (ICC = 0.92).

CONCLUSION

This pilot study demonstrates a high correlation between PET-measured IRCR and PFT-measured KCO, suggesting that 15O-CO PET imaging may be useful for measuring regional differences in CO diffusion.

CLINICAL RELEVANCE/APPLICATION

Estimating regional CO diffusion would be a highly useful biomarker of treatment efficacy for pulmonary vascular-targeted therapies for pumonary arterial hypertension.

SSC10-03 82-Rb PET/CT in Malignant Tumors: First Systemic Analysis

Monday, Nov. 27 10:50AM - 11:00AM Room: S505AB

Participants
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PURPOSE

To quantitatively and qualitatively document 82-Rb (Rb) uptake in malignant tumors.

METHOD AND MATERIALS

18 malignant tumors in 18 patients incidentally captured on Rb cardiac PET/CT were included. Ratios of SUVmax (SUV) of each lesion (SUVL) to SUV of the mediastinal blood pool (SUVMBP), lung (SUVLU) and subcutaneous fat (SUVSCF) were calculated (qualitative assessment). Paired t-test and correlation analysis was used to assess the agreement between ratios of SUVL and SUVMBP, SUVLU, SUVSCF on rest and stress images. Lesions (L) were also qualitatively assessed for their uptake (UT) using scores 1 (SCF UTMBP UT). All assessments were conducted on rest and stress images.

RESULTS

Histology: 16 lung cancer (13 NSCLC; 2 small cell; 1 well diff carcinoid), 1 ductal breast cancer and 1 follicular lymphoma. Size range: From 1.0 to 5.0 cm. Mean + SD and median: 2.6 + 1.0 and 2.7, respectively. Quantitative assessment: SUVL/SUVMBP, SUVL/SUVLU and SUVL/SUVSCF ranged from 0.5 to 3.0, 0.5 to 6.2 and 1.5 to 20.3, respectively, on rest images and 0.3 to 3.7, 0.3 to 6.9 and 1.4 to 20.6, respectively, on stress images. Mean + SD and median for SUVL/SUVMBP, SUVL/SUVLU and SUVL/SUVSCF were 1.4 + 0.7 and 1.3, 2.9 + 1.5 and 2.7 and 11.4 + 5.5 and 11.1, respectively, on rest images, and 1.5 + 0.8 and 1.5, 2.7 + 1.6 and 2.5 and 10.6 + 5.5 and 10.4, respectively, on stress images. There was no statistically significant difference between rest and stress values for SUVL/SUVMBP, SUVL/SUVLU and SUVL/SUVSCF. Correlation analysis between rest and stress values for SUVL/SUVMBP, SUVL/SUVLU and SUVL/SUVSCF showed very strong correlation with correlation coefficients of 0.82, 0.89 and 0.91, respectively. Qualitative assessment: There were 10 lesions with score 3, 6 lesions with score 2 and 2 lesions with score 1.

CONCLUSION

Malignant lesions can be readily depicted and their uptake quantified on Rb PET/CT. Specifically, using the ratio of SUVmax of lesions to SUVmax of subcutaneous fat, there is a high target-to-background ratio of Rb signal.

CLINICAL RELEVANCE/APPLICATION

Quantitative Rb PET/CT has the potential to be used as a clinical imaging tool to quantify tumor perfusion.

SSC10-04 Correlation of V/Q Scans and Pulmonary Artery Pressures to Determine Pulmonary Endarterectomy

Outcomes

Monday, Nov. 27 11:00AM - 11:10AM Room: S505AB

Participants
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James A. Scott, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To determine if there is a correlation between the counts found on perfusion images pre and postoperatively relative to the pulmonary artery pressure changes in patients who underwent endarterectomy for chronic pulmonary embolism.

METHOD AND MATERIALS

IRB approved and HIPAA compliant single center retrospective study of all patients who underwent pre and post endarterectomy VQ scans for chronic pulmonary embolism in the period of 2008-2015. Studies were acquired at outside institutions were excluded. Pulmonary artery pressures prior and posterior to surgery available in the EMR were further analyzed. ROIs were manually selected in posterior views only using the Polygon tool from the Siemens MI applications. Each lung was divided in two for a total of 4 segments. Mirror tool was used to reproduce the contour selection in the contralateral side increasing repeatibility. Measurements for each segment included: size, total counts and pixels. Operative notes were used to select segments in which surgery was successful. Pearson and Spearman's Rho correlation tests were applied.

RESULTS

102 cases had pre and postoperative VQ scans, only 73 had concurrent PA measurements. Surgeons correctly predicted the outcome in 50/73(68%) of cases relative to pre and post segmental total-count difference. 121 segments in 50 subjects underwent successful surgery and were further analyzed. All preoperative PA pressures (average 77.2) demonstrated a decrease (average 28.3) or positive outcome.PA pressures decreased on average 38% after surgery. Moderate positive correlation was found between PA pressure drop and the increase in total-counts in those segments where clot was removed, R=0.501 p=0.003. The segment with the highest percentage of improvement with surgery was the right lower lung 16% followed by right upper 14.4%, left upper 13% and left lower 10.5% of total counts.

CONCLUSION

Pulmonary segmental VQ scan total counts have a moderately positive proportional correlation with the degree of PA pressure change seen on pre and post endarterectomies.

CLINICAL RELEVANCE/APPLICATION

VQ perfusion quatitations may be used to determine the surgical outcome of endarterectomy for chronic pulmonary embolism and are a good representation of the proportion of pulmonary pressure drop after surgery. Serial VQ scans can reliably be used in the surveillance of post endarterectomy patients as a screening tool for monitoring disease improvement or recurrence.

SSC10-05 Relationship of Carotid Artery F-18 NaF Uptake and Cerebral Ischemia: Comparison with F-18 FDG

Monday, Nov. 27 11:10AM - 11:20AM Room: S505AB

Participants
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PURPOSE

Atherosclerosis is characterized by the formation and progression of plaque which is a dynamic and complex process involving various pathophysiologic steps including inflammation and calcification. F-18 FDG (FDG) is the most widely validated PET tracer for the evaluation of atherosclerotic inflammation. F-18 sodium fluoride (NaF) provides potential discrimination between active unstable microcalcification and established dormant calcification. The purpose of this study was to evaluate the relationship between NaF uptake in carotid artery and cerebral ischemic changes on MRI in comparison with FDG.

METHOD AND MATERIALS

A total of 24 patients with carotid artery stenosis of 50% or greater determined by using ultrasonography were examined with NaF PET/CT, FDG PET/CT and brain MRI. In one patient, only unilateral carotid artery was used because of indwelling stent. PET emission scanning of the neck region with a 15-min acquisition of one bed position was performed at 60 min after each radiotracer injection. NaF and FDG uptake in carotid arteries were quantified using maximum standardized uptake value (SUVmax). MRI findings were characterized as mild ischemic changes (grade 1), moderate ischemic changes (grade 2), and severe ischemic changes (grade 3) in bilateral cerebral hemispheres.

RESULTS

Twenty-three hemispheres were considered grade 1; 17, grade 2; and 7, grade 3 on MRI. The mean (±S.D.) NaF SUVmax in grade 3 (3.32±0.93) was significantly higher than that in grade 1 (2.02±0.59) and grade 2 (2.22±0.54). There was no significant association between FDG SUVmax and MRI grade.

CONCLUSION

These preliminary results suggest that NaF uptake in carotid artery seems to be useful for the assessment of cerebral ischemic changes.

CLINICAL RELEVANCE/APPLICATION

NaF uptake in carotid artery may be useful for the assessment of cerebral ischemic changes.

SSC10-06 Added Value of Myocardial Perfusion SPECT/CT Studies: Detection of Incidental Pulmonary Artery Dilatation

Monday, Nov. 27 11:20AM - 11:30AM Room: S505AB

Participants
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PURPOSE

To evaluate the incidence of undiagnosed pulmonary artery dilatation using gated CT images in patients with normal myocardial perfusion.

METHOD AND MATERIALS

This was a retrospective review of 200 consecutive patients who underwent a myocardial perfusion SPECT/CT study with a normal myocardial perfusion. The gated CT images were reviewed using a validated mean main pulmonary artery diameter (mPAD) measurement method that has previously been correlated with pulmonary artery pressure measured by right heart catheterization. The indication for the test and patient characteristics were collected. Previously reported mPAD cut-offs (>29.5mm and >31.5mm) were used to stratify patients. The frequency distribution was tabulated for the discrete variables and chi-square test was used for statistical comparison. Continuous variables were compared by non-parametric Mann-Whitney U test and correlations were dony by spearman-rank correlation.

RESULTS

Of the 200 patients, 100 were men and 100 were women. The mean age was 58.7 years. The most common indication was dyspnea (58.9%) followed by pre-operative work-up (22.3%) and chest pain (13.9%). The mean mPAD measurement was 26.3mm. There was a significant correlation between BMI and mPAD (ρ 0.28; $p<0.001$). In our cohort of patients, 23% (46/200) had a mPAD >29.5mm and 13.5% (30/200) patients had a mPAD of >31.5mm suggesting a high prevelance of incidental pulmonary arterial dilatation. Among patients undergoing a myocardial perfusion study for pre-operative work-up, 35.6% patients had a mPAD >29.5mm and 26.7% had a mPAD >31.5mm. There was a higher prevelance of congestive heart failure (62.5% vs 19.6%; $p<0.001$) and hypertension (78.3% vs 21.7%; $p<0.02$) in patients with mPAD >29.5mm. Similarly, there was a high prevelance of congestive heart failure ($p<0.001$), hyperlipidemia ($p<0.04$) and hypertension ($p<0.04$) in patients with mPAD >31.5mm

CONCLUSION

Incidental pulmonary artery dilatation can be detected in as many as 23% of patients with normal myocardial perfusion using the gated CT images and can be an invaluable tool in the early detection of dilated pulmoary arteries in patients with a low index of clinical suspicion

CLINICAL RELEVANCE/APPLICATION

Gated CT images of myocardial perfusion studies can detect incidental pulmonary arterial dilatation and can be evaluated at no extra-cost or procedure to the patient and should be evaluated in all myocardial perfusion studies.

SSC10-07 Quantitative Assessment of Cardiac FDG Uptake During a Long-term Follow-up of Steroid Therapy in Patients with Cardiac Sarcoidosis

Monday, Nov. 27 11:30AM - 11:40AM Room: S505AB

Participants
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PURPOSE

Several studies have confirmed that FDG PET has a high diagnostic accuracy in detecting active myocardial inflammation caused by cardiac sarcoidosis (CS). The aim is to estimate the long-term prognostic value of it during corticosteroid therapy.

METHOD AND MATERIALS

Fifty-two consecutive patients (pts) with CS (23 men and 29 women; 54 ± 10 y) were enrolled in the study. A final diagnosis of CS was made based on the guidelines which were recently revised by the Japanese Circulation Society in 2016. After establishing the diagnosis, all pts received corticosteroid therapy, which was initiated with 30 mg/day of predonisone, followed by gradual tapering over a period of 6-12 months to a maintenance dose of 5-10 mg/day. They underwent FDG PET/CT having a low carbohydrate diet with < 12-h overnight fasting and an injection of heparin. On the PET/CT fusion images, a standard uptake value (SUV) was obtained in the heart and ascending aorta to generate a target-to-background ratio (TBR).

RESULTS

Twenty-five pts had 2 serial PET scans, 10 had 3 serial scans, and 11 had more than 3 scans, resulting there were 151 PET scans.

The time interval between two serial scans was 9.8 ± 8.9 months (2 to 54 months). In 20 pts who were followed at baseline and within 6 months after the initiation of steroid therapy, TBRs significantly decreased from 4.95 ± 2.71 to 2.74 ± 1.30 (P < 0.0001). During the long-term follow-up (5.3 ± 1.9 years), there were 31 pts (59.6%) with adverse cardiac events (2 cardiac deaths; 14 arrhythmias which needed emergency treatment with implantable devices; and 15 hospital admissions due to severe heart failure, while 21 pts remained stable or were improved clinically. In 7 pts, inflammatory exacerbation appeared with an increase in TBR. Eventually, there were smaller percent reduction in TBR among the pts with adverse events than those without (19.9 ± 41.5 vs. 51.9 ± 18.2, P = 0.04).

CONCLUSION

Cardiac events of serious consequences appeared in the majority of patients with cardiac sarcoidosis (CS) during the long-term follow-up of corticosteroid therapy. FDG PET could detect cardiac inflammatory process, hence it would be a predictive biomarker for prognosis of CS.

CLINICAL RELEVANCE/APPLICATION

Adverse cardiac events appeared in the majority of patients with cardiac sarcoidosis (CS) during the long-term follow-up of steroid therapy. FDG PET could detect inflammatory process, hence it would be a predictive biomarker of prognosis of CS.

SSC10-08 Detection and Monitoring of Cardiac and Extra-Cardiac Thoracic Sarcoidosis Using F-18 FLT PET/CT: Comparison with F-18 FDG PET/CT

Monday, Nov. 27 11:40AM - 11:50AM Room: S505AB

Participants
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PURPOSE

F-18 FDG (FDG) PET has been proposed to play a role in the diagnosis and therapeutic monitoring of sarcoidosis. However, assessing inflammatory lesions in cardiac sarcoidosis using FDG can be challenging because of normal myocardium uptake. The purpose of this study was to compare the uptake of 3'-deoxy-3'-18F-fluorothymidine (FLT) and FDG in the evaluation of detection and monitoring of cardiac and extra-cardiac thoracic sarcoidosis.

METHOD AND MATERIALS

FLT and FDG PET/CT studies were performed in 20 patients with newly diagnosed sarcoidosis. A follow-up PET/CT scan was also performed after immunosuppressive therapy in 5 patients. The patients had fasted for at least 18 h before FDG PET/CT, but were given no special dietary instructions before FLT PET/CT. Uptake of FLT and FDG was examined visually and semiquantitatively using maximal standardized uptake value (SUVmax).

RESULTS

Two patients had cardiac sarcoidosis, 7 had extra-cardiac thoracic sarcoidosis, and 11 had both cardiac and extra-cardiac thoracic sarcoidosis. Before therapy, 4/20 FDG scans for cardiac region were visually rated as inconclusive because FDG pattern was diffuse, whereas no FLT scans were rated as inconclusive. The sensitivity of FDG PET/CT for detection of cardiac lesions was 85% and the specificity, 100%. The corresponding values for FLT PET/CT were 92% and 100%, respectively. The mean FDG SUVmax of cardiac lesions was significantly higher than that of FLT SUVmax (P<0.005). Before therapy, both FDG and FLT PET/CT detected all 24 extra-cardiac lesions. The mean FDG SUVmax of extra-cardiac lesions was significantly higher than that of FLT SUVmax (P<0.001). After therapy, 3/5 FDG scans for cardiac region were visually rated as inconclusive, whereas no FLT scans were rated as inconclusive. The mean FDG SUVmax and FLT SUVmax of both cardiac and extra-cardiac lesions after therapy were lower than those of before therapy.

CONCLUSION

These findings suggest that FLT PET/CT could detect and monitor cardiac and extra-cardiac thoracic sarcoidosis as well as FDG PET/CT.

CLINICAL RELEVANCE/APPLICATION

FLT PET/CT could detect and monitor cardiac and extra-cardiac thoracic sarcoidosis as well as FDG PET/CT.

SSC10-09 Z-Score for Cardiac Transthyretin Amyloidosis (ATTR)

Monday, Nov. 27 11:50AM - 12:00PM Room: S505AB

Participants
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PURPOSE

Definitive diagnosis of cardiac involvement in Transthyretin amyloidosis (ATTR) requires myocardial biopsy, that is invasive, expensive and it may be complicated by adverse events. Although scintigraphy, using bisphosphonates, has been proposed as an accurate method for the detection of myocardial TTR amyloid load, a consensus on scan interpretation is lacking. Purpose of the present study is to overtake the qualitative analysis using a semi-quantitative approach to easily and objectively classify the degree of myocardial amyloid load in ATTR patients.

METHOD AND MATERIALS

N.6939 99mTc-MDP bone scans, consecutively performed at our Institution, for oncological or rheumatologic conditions (2012-2016), were retrospectively reviewed, using qualitative inspection, to identify those displaying any cardiac uptake. A visual score (Perugini et. al1) and a heart-to-soft tissue (mid-thigh) semi-quantitative uptake ratio have been assigned to the selected scans. A group of 65 healthy controls (HC) (i.e. no cardiac uptake / visual score 0) have been used for comparison and Z-score creation.

RESULTS

N. 56/6939 (0.8%) patients (41M/15F) aged 79±7.35 years showed significant cardiac uptake of 99mTc-MDP on visual inspection. N.39 (70%) were assigned a visual score 1, N.14 (25%) a score 2 and 3 (5%) a score 3. The mean proposed semi-quantitative ratio was 3.8±1.5 for visual score 1, 8.6±3.1 for visual score 2 and 15.9±3.3 for visual score 3. The HC group patients (visual score 0) showed a ratio of 2.75 ± 0.7. Mean calculated Z-Score using HC group as reference was 1.54 for visual score 1, 7.94 for visual score 2 and 17.07 for score 3.

CONCLUSION

The proposed heart-to-mid-thigh semi-quantitative ratio proved to be an easy method to quantify the cardiac uptake of 99mTc-MDP. Z-score showed a good correlation with the score proposed by Perugini et. al and it could offer a more quantitative approach than visual analysis. Further investigations, including genetic analysis, will be needed to help identify amyloid subtypes namely wild-type ATTR (ATTRwt) or genetic ATTR, the latter susceptible of therapeutic options.

CLINICAL RELEVANCE/APPLICATION

Transthyretin-cardiac amyloidosis is rare and underdiagnosed. Early detection is increasingly important in light of the emerging therapies. 99mTc-bisphosphonate tracers have proved highly sensitive for a noninvasive diagnosis

SSC11

Neuroradiology (Functional MRI)

Monday, Nov. 27 10:30AM - 12:00PM Room: N229

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Joshua S. Shimony, MD, PhD, Saint Louis, MO (*Moderator*) Nothing to Disclose
Michelle M. Miller-Thomas, MD, Saint Louis, MO (*Moderator*) Nothing to Disclose

Sub-Events

SSC11-01 Impact of Glycemic Control and Cardiovascular Disease Measures on Hippocampal Functional Connectivity in African Americans with Type 2 Diabetes: A Resting State fMRI Study

Monday, Nov. 27 10:30AM - 10:40AM Room: N229

Participants
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Albert Montillo, PhD, Dallas, TX (*Presenter*) Nothing to Disclose

PURPOSE

This study tests the hypothesis that inadequate Type 2 diabetes (T2D) management, including fine gradations of glycemic control, increasing measures of cardiovascular disease (CVD) and renal disease, leads to decreased hippocampal connectivity in African Americans (AA).

METHOD AND MATERIALS

The study includes 155 AA with T2D, 57% female with mean age of 59.2 years for whom diabetes management was quantified. Subjects had a mean diabetes duration of 14.5 years, hemoglobin A1c (HbA1c) of 7.97%, estimated glomerular filtration rate (eGFR) of 86.6 mL/min/1.73m2, and coronary artery calcium (CAC) score of 475.4mg. An 8min resting state fMRI was acquired and structural and functional MRI were co-registered, normalized to MNI space, and mean fMRI time courses per region were computed, and then pairwise region connectivity using Pearson's correlation was computed. The regions and connections form a graph of nodes and edges. Correlation was thresholded to retain the top 10% edges. The degree of each region which represents the overall connectivity of the region to the rest of the brain was computed to form a brain health measure. A linear support vector regression model was fit to predict the brain health measure using 10-fold cross-validation, while permutation testing was used to compute model reliability. The predictor set consists of diabetes measures: HbA1c, renal disease measures: eGFR, c-reactive protein (CRP), and urine albumin-to-creatinine ratio (ACR), and CVD measure: CAC. Our model is fully adjusted for education, age, sex and BMI.

RESULTS

The functional connectivity of the hippocampus was found to be significantly impacted by HbA1c and CAC with R2=1.9%, p=0.00047. Lower functional connectivity of right hippocampus (hippocampal degree) was associated with poor glycemic control (higher HbA1c) and greater calcified plaque (higher CAC). The results complement previous research demonstrating an inverse association between CAC and Montreal Cognitive Assessment test scores.

CONCLUSION

This work provides new evidence that elevated HbA1c and CAC are associated with decreasing functional connectivity of the right hippocampus in AAs with T2D.

CLINICAL RELEVANCE/APPLICATION

The results suggest that maintaining fine degree of glycemic control and cardiovascular health may support optimal hippocampal function, a structure critical for successful memory retrieval.

SSC11-02 Functional MRI Neuroimaging Study of Earnings Management Decision by Business Managers

Monday, Nov. 27 10:40AM - 10:50AM Room: N229

Awards
Student Travel Stipend Award

Participants
Eslam Y. Youssef, MD, Toledo, OH (*Presenter*) Nothing to Disclose
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PURPOSE

Although functional MRI (fMRI) techniques have been increasingly used to study human cognitive functions, there has been a lack of research on the applications of fMRI on brain activation of business managers. Specifically, there is research gap in using fMRI to examine managers' earning management decisions. Therefore, the current study to report on a newly developed paradigm for neuroimaging study of neuro-accounting research, and the new findings related to brain activation associated with earnings management as a mechanism to avoid violating debt covenants.

METHOD AND MATERIALS

The participants were 52 local business owners and managers, males and females, age 18 to 60 years old. All participants had some educational background in accounting, business or finance and significant employment in managerial capacity. To probe the related neurocircuits, we designed different scenarios in which firms are either close (CLOSE) or far (FAR) from violating debt covenants. The subject is assigned a role of a manager to choose whether or not to manage earnings in order to avoid debt covenant violations and the subject's managing style is evaluated in every scenario. The influences of subject's perception of his/her supervisor managing style are also evaluated in every scenario.

RESULTS

We found that there was greater pre-frontal cortex (PFC) activation in CLOSE than in FAR scenarios. These results suggest that earning management decisions under high levels of financial stress requires more PFC cognitive functions. We also found that there was greater activation in the bilateral nucleus accumbens (NA) and the left amygdala (Amy) in CLOSE than FAR scenarios.

CONCLUSION

The final findings reveal different activation in emotion response and cognitive processing when the company is close vs. far from violating debt covenants which influences the manager's managing style and performance evaluation approach on manager's earning management decision and related brain activation. The final findings also suggest influences of manager's perception of his/her supervisor's managing style on manager's emotion responses during earning management decision making.

CLINICAL RELEVANCE/APPLICATION

FMRI can demonstrate brain activation associated with earnings management behavior to avoid violating debt covenants by business managers.

SSC11-03 Application of fMRI in the Assessment of Neuronal Activity in Patients with Fragile X Syndrome

Monday, Nov. 27 10:50AM - 11:00AM Room: N229

Participants
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PURPOSE

Fragile X syndrome (FXS) is the most common inheritable mental disease in children. The main cause of the disorder is CGG•GCC repeat expansion in 5' promoter region of the FMR1 gene. Commonly during the routine MRI study, the changes in brain structures in patients with fragile X syndrome are not observed. Thus the application of fMRI technique that provides information on the structure of neural networks in brain, is of a primary interest for diagnostics of the fragile X syndrome, as well as it is used for patients during examination in neurology and psychiatry. The aim of the study was to assess the neural activity of different brain regions in patients and the control group by resting state fMRI.

METHOD AND MATERIALS

The fMRI was performed on «Achieva» (Philips) scanner with a magnetic field strength of 1.5 T. Study involved two groups of patients: 5 children with confirmed fragile X syndrome and 8 healthy volunteers. Independent Component Analysis and seed-based correlation analysis were used. Statistical analysis was performed using FSL (fMRI Brain Software Library).

RESULTS

The fMRI study revealed a default mode network of brain function in patients with the fragile X syndrome, as well as in the control group. Furthermore, it was found that a default mode network of the brain in patients with fragile X syndrome and control groups do not have statistical significance ($p>0.05$), which may indicate that the basal activity of neurons in patients with fragile X syndrome it is not reduced. Also we have found a significant ($p<0.05$) reduction the functional connectivity within the prefrontal cortex of the frontal-parietal hemispheric network in the resting state in patients with fragile X syndrome.

CONCLUSION

New data of functional status of the brain in patients with fragile X syndrome were received. The significant reduction the functional connectivity within the prefrontal cortex of the frontal-parietal hemispheric network in the resting state in patients with fragile X syndrome was found.

CLINICAL RELEVANCE/APPLICATION

Neurology, psychiatry, genetics

SSC11-04 fMRI Markers of Decision-Making under Uncertain Conditions

Monday, Nov. 27 11:00AM - 11:10AM Room: N229

Awards
Student Travel Stipend Award

Participants
Danielle C. Farrar, MA, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

To describe imaging markers of decision-making under certain and uncertain conditions in normal individuals, in order to provide baseline activity in which to compare impaired decision-making in such pathological states as schizophrenia, ADHD, and obsessive-compulsive disorder.

METHOD AND MATERIALS

Nineteen healthy subjects ages 18-35 completed a novel decision-making card-matching task using a Phillips T3 Scanner. Functional data were collected in six functional runs of a single shot echo-planar imaging sequence (TR = 2 s, TE = 35 ms, 30 slices, 3 mm slice thickness, inplane resolution 3 mm × 3 mm) and a T1-weighted structural image (1 mm3 voxel size). In one condition of the card-matching task, the participant was certain of the rule to apply to match the cards; in the other condition, the participant was uncertain. We performed cluster-based comparison of the two conditions using FSL FEAT.

RESULTS

The uncertain > certain comparison yielded 3 large clusters through general linear model (GLM) analysis using FSL FEAT - a midline cluster that extended through midbrain, the thalamus, bilateral prefrontal cortex, the striatum, and bilateral clusters that extended through the parietal cortex and occipital cortex. The certain > uncertain comparison yielded bilateral clusters in the insula that extend into the boundary of the parietal and temporal lobe, as well as a medial frontal cluster.

CONCLUSION

The involvement of the insula, parietal cortex, temporal cortex, ventromedial cortex, and orbitofrontal cortex that showed increased activation in the certain condition are generally associated with rule certainty and reward, which reinforces the notion that certainty is inherently rewarding. For the uncertain condition, we expected to see involvement of the prefrontal cortex, parietal cortex in resolving uncertainty, as well as involvement of the striatum, thalamus, amygdala and hippocampal were expected in rule updating; however, the unexpected involvement of occipital cortical involvement and midbrain involvement may be attributed to increased visual attention and increased motor control.

CLINICAL RELEVANCE/APPLICATION

We have established a network of functional brain regions involved in certain and uncertain decision-making conditions using fMRI and a novel paradigm on which to explore pathological disease states.

SSC11-05 Impaired Executive Control Function in Unilateral Temporal Lobe Epilepsy Revealed by Extrinsic Brain Network Connectivity: A Resting-state Functional fMRI Study

Monday, Nov. 27 11:10AM - 11:20AM Room: N229

Participants
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PURPOSE

To investigate functional connectivity (FC) between resting-state networks (RSNs) in unilateral intractable temporal lobe epilepsy (TLE) patients with abnormal executive control function (ECF).

METHOD AND MATERIALS

Forty left TLE patients and twenty-three volunteers were recruited for resting-state fMRI scanning. The patient groups were

divided into two subgroups according to ECF performance: ECN decreased group as subgroup 1 (G1) and ECN normal group as subgroup 2 (G2). The healthy control group (HC) included all 23 volunteers. All the subjects were received neuropsychological tests, including Wisconsin Card Sorting Test (WCST) and Montreal Cognitive Assessment (MoCA). Group-information-guided independent component analysis (GIG-ICA) was employed to estimate RSNs of all subjects. A general linear model with age, sex and education as covariates was used to analyze which pairs of internetwork FC reached significant differences ($p<0.05$) among G1, G2 and HC. Pearson correlation between FC, clinical features and neuropsychological performances were also observed though partial correlation analysis with age, sex and edu as covariates ($p<0.05$).

RESULTS

Eleven meaningful RSNs were identified though empirical analysis. G2 exhibited decreased FC between ECN and DMN network when compared with G1 ($p=0.000$, bonferroni corrected) and HC ($p=0.000$, bonferroni corrected). However, G1 showed no significant difference with control group. Furthermore, FC of patients had significantly negative correlation with WCST performance and duration of disease ($p=0.000$), but have no correlation with MoCA. Besides, significantly positive correlation were also found between FC with age-onset ($p=0.000$). However, there was no significant correlation between FC and neuropsychological tests of HC.

CONCLUSION

Our study suggested that FC abnormal between ECN and DMN may potentially act as an imaging biomarker candidate, which can not only differentiate ECF normal and ECF impairment, but also can reflect ECF impairment degree of TLE patients. Furthermore, such FC pattern may also provide us new insight into understanding ECF pathophysiological mechanisms of unilateral intractable TLE.

CLINICAL RELEVANCE/APPLICATION

Neuropsychological performance was closely related to functional connectivity between large-scale networks which can be well depicted by fMRI.

SSC11-06 Accuracy of Resting-State fMRI Language Networks in Brain Tumor Patients: Comparison Between Blind Seed-Based Analysis versus Independent Component Analysis

Monday, Nov. 27 11:20AM - 11:30AM Room: N229

Participants
Ammar A. Chaudhry, MD, Corona, CA (*Presenter*) Nothing to Disclose

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PURPOSE

Compare concordance of language networks derived fromSeed Based Analysis (SBA) resting-state fMRI in patients with brain tumors with Independent Component Analysis (ICA)

METHOD AND MATERIALS

Resting state fMRI was performed and language networks identified for patients presenting for presurgical task-fMRI mapping between 1/1/2009 and 7/1/2015. 79 patients were analyzed of which 49 met the inclusion criteria (presence of brain tumors without history of prior brain surgery, adequate task-fMRI performance). Language networks were obtained from rs-fMRI using ICA with 50 components and SBA using blind seed in the IFG from the rs-fMRI maps. Seeds generated from maximal task-fMRI activation in the IFG were used as control. Rs-vs-task-fMRI concordance for each resultant map was measured using Dice coefficients across varying fMRI thresholds. Multi-threshold Dice coefficient volume under the surface (DiceVUS) and maximum Dice coefficient (MaxDice) were calculated. ANOVA was performed to determine significant differences in DiceVUS and MaxDice between the methods of analysis.

RESULTS

Paired T-test showed there is no statistical difference between blinded-SBA and ICA-50 ($P<0.4694$). Also, there is statistical difference between task-SBA and blinded-SBA ($P<0.001$) and task-SBA and ICA-50 ($P<0.0178$).Group mean DiceVUS and MaxDice were highest for the task-based SBA than both blind-SBA and ICA. Paired T-test demonstrate no significant diffference between the blind-SBA and ICA. ANOVA with Tukey HSD demonstrated statistically significant differences for both DiceVUS and MaxDice between blind-SBA and ICA. The violin plot (figure 6) demonstrates the data distribution relative to the mean for ICA, SBA, RBA (AMPLE) and blind-SBA (left, right, optimal; respectively). ICA and SBA demonstrate similar degree of variability of values across subjects relative to the mean and kernel density estimation (KDE).

CONCLUSION

We demonstrate that blind rs-FMRI and ICA have similar accuracy in identifying language networks on rs-fMRI. Both the group mean MaxDice and DiceVUS were greater for task-SBA than ICA and blind-SBA.

CLINICAL RELEVANCE/APPLICATION

Blind-SBA analysis can be utilized to reliably identify neuronal language networks on pre-operative studies, especially in patient who are unable to perform all the tasks required in conventional task-fMRI.

SSC11-07 Self-Regulation of the Primary Auditory Cortex Activity via Directed Attention Mediated By Real-Time fMRI Neurofeedback

Monday, Nov. 27 11:30AM - 11:40AM Room: N229

Participants
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PURPOSE

To determine the potential efficacy of treating auditory cortex hyperactivity by self-regulation of the primary auditory cortex (A1) based on real-time functional magnetic resonance imaging neurofeedback training (fMRI-NFT).

METHOD AND MATERIALS

10 healthy volunteers with normal hearing (no more than 1 frequency >40 dB on a standard audiogram) underwent 5 fMRI-NFT sessions. Each session was composed of a simple auditory fMRI followed by 2 runs of A1 fMRI-NFT. FMRI data was acquired using 2D, single-shot echo planar imaging during all 3 runs using a 3T. The auditory fMRI was comprised of 6 blocks, each containing a 20s period of no auditory stimulation followed by a 20s period of white noise stimulation at 90 dB. A1 activity, defined from a region using the activity during the preceding auditory run, was continuously updated during fMRI-NFT using a simple bar plot, and was accompanied by white noise (90 dB) stimulation for the duration of the scan. Each fMRI-NFT run contained 8 blocks, each separated into a 30s relax period followed by a 30s lower period. Subjects were instructed to watch the bar during the relax condition and actively lower the bar by decreasing A1 activity during the lower condition. The average A1 activity was measured from the simple auditory task from each session. Average A1 deactivation was extracted from each fMRI-NFT run, representative of A1 self-regulation performance.

RESULTS

A one-way ANOVA evaluated the effect of session on A1 activity during the simple auditory task. The main effect of session was not significant ($p = 0.41$, sphericity assumed, two-tailed). A 5x2 (session by run) ANOVA was carried out on A1 deactivation during fMRI-NFT. There was a significant effect of session ($p = 0.0275$, sphericity assumed, one-tailed) and a significant interaction effect ($p = 0.0395$, sphericity assumed, one-tailed). The most successful subjects reportedly adopted mindfulness tasks associated with directed attention.

CONCLUSION

For the first time, fMRI-NFT has been applied to teach A1 self-regulation using more than 1 session. This is important to therapeutic development as it is unlikely a single fMRI-NFT session will reverse the effects of tinnitus.

CLINICAL RELEVANCE/APPLICATION

Chronic tinnitus has implications of impaired auditory and attentional networks. Our study indicates that fMRI-NFT may provide an innovative approach to alter of these systems simultaneously.

SSC11-08 Characterization of Obsessive-Compulsive Disorder Using a Multiparametric Classification Approach Based on Resting-State fMRI

Monday, Nov. 27 11:40AM - 11:50AM Room: N229

Participants
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PURPOSE

Obsessive-compulsive disorder(OCD)is a common,heritable and disabling neuropsychiatric disorder.Recent advances in resting-state functional magnetic resonance imaging(rs-fMRI)have facilitated the abnormality of a specific network of cortico-striato-limbic regions.However,the vast majority of these studies published so far have been based on average differences between groups.Whether functional neuroimaging could be used to inform the clinical assessment of individual OCD patients remains unclear.The machine learning approach is a promising technique which allows the classification of individual observations into distinct groups and bears the advantage of individualized judgement.Thus,in current study,we aimed to apply one of the machine learning approach known as Support Vector Machine(SVM)to distinguishing drug-naive OCD patients from healthy control subjects(HCS)based on various rs-fMRI parameters.

METHOD AND MATERIALS

A total of 54 drug-naive OCD patients and 54 age,sex,handedness and years of education well matched HCS were recruited in current study.The rs-fMRI were obtained via a 3.0 T GE MRI system.Four different rs-fMRI parameter maps including amplitude of low-frequency fluctuation (ALFF),fractional amplitude of low frequency fluctuation (fALFF),regional homogeneity (ReHo) and functional connectivity strength (FCS) were separately calculated using REST software.Subsequently,all these rs-fMRI parametric maps were used to discriminate OCD patients from HCS based on leave one-out cross-validation approach with SVM implemented in the PROBID software package.We also drew a receiver operating characteristic(ROC)curve to help evaluate the performance of each parameter.

RESULTS

The classification accuracy,sensitivity and specificity for SVM classifier of each rs-fMRI parameter are presented in the Figure.Overall,the SVM classification accuracies for the four rs-fMRI parameters were all above 74%.The highest classification accuracy(95.37%,$p<0.001$)was achieved when ALFF maps were employed.

CONCLUSION

Our findings suggest that the four rs-fMRI parameters would exhibited significant differences in predicting diagnosis of OCD,and ALFF showed the highest accuracy,which is fit to be an assistant measure in clinical practice to help identify OCD at the individual level.

CLINICAL RELEVANCE/APPLICATION

Application of SVM to ALFF maps could be used to aid the identification of OCD in clinical practice.

SSC11-09 Identification of the Sensorimotor Network in Brain Tumor Patients Using Resting-State Functional MRI

Monday, Nov. 27 11:50AM - 12:00PM Room: N229

Participants
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PURPOSE

Evaluate the ability of resting-state fMRI in localizing the sensorimotor network (SMN) and its individual components in patients with brain tumors, using independent component analysis (ICA) and seed-based analysis.

METHOD AND MATERIALS

This is a retrospective analysis of 29 patients with brain tumors presenting for fMRI mapping. ICA with a predetermine output of 20 components was performed for each patient. Eight seed-based analyses were performed, with seeds allocated in the medial, knob-like area and lateral precentral gyrus and in the posterior superior frontal gyrus of each hemisphere. The ability of identifying a complete SMN or any of its parts, composed by bilateral primary sensorimotor cortex (PSMC) and bilateral supplementary motor area (SMA) with ICA and seed-based analysis was subjectively assessed. For each of the precentral gyrus seed-based analysis, the capacity of localizing the correspondent region of the seed in the contralateral hemisphere was also assessed.

RESULTS

ICA identified a complete SMN in 13 patients (44%), the left PSMC in 18 patients (62%), the right PSMC in 18 patients (62%), the left SMA in 18 patients (62%) and the right SMA in 18 patients (62%). Combined analysis of the correlation maps generated by all seeds identified a complete SMN in 15 patients (51%), the left PSMC in 17 patients (58%), the right PSMC in 18 patients (62%), the left SMA in 28 patients (96%) and the right SMA in 27 patients (93%). Combined ICA and seed-based analysis identified a complete SMN in 20 patients (68%), the left PSMC in 22 patients (75%), the right PSMC in 22 patients (75%), the left SMA in 28 patients (96%) and the right SMA in 27 patients (93%). Seed-based analysis of the precentral gyrus identified the correspondent area in the contralateral hemisphere in 154 of 174 analyses (88%).

CONCLUSION

Combining ICA and seed-based analysis increases the ability of resting-state fMRI in identifying the SMN and its components. Seed-based analysis consistently identifies the correspondent area of the seed in the contralateral hemisphere.

CLINICAL RELEVANCE/APPLICATION

Resting-state fMRI can be used to identify the sensorimotor network, this being especially valuable when brain lesions generates morphological distortion and patients are unable to perform the tasks required by conventional task-fMRI.

SSC12

Neuroradiology (White Matter Diseases: Do They Matter?)

Monday, Nov. 27 10:30AM - 12:00PM Room: N226

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Peter B. Barker, DPhil, Baltimore, MD (*Moderator*) Nothing to Disclose
Ronald L. Wolf, MD, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSC12-01 Clinical Use of Brain MRI Biomarkers for Multiple Sclerosis: A Health Economical Study in the United States

Monday, Nov. 27 10:30AM - 10:40AM Room: N226

Participants
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CONCLUSION

The accurate and reproducible assessment of MRI lesions and brain atrophy in MS is not only clinically important, but also has major health economic benefits thanks to the reduction of medication costs. [1] Sa et al. 2015 [2] Gauthier et al., Journal Neurological Sciences 2009 [3] Giovannoni et al. Brain Health 2015 [4] Hartung et al., Neurology. 2015 26 [5] Rio et al., EJN 2012 [6] Rojas et al., Neurological Research 2014

Background

Since Multiple Sclerosis (MS) is an incurable chronic disease, the focus of therapy is to slow down the relapses and disability progression. Currently, over 10 disease modifying treatments are clinically approved for relapsing remitting MS. However, providing the best treatment for each patient remains a major challenge as over 25-30% of treatments have a suboptimal effect [1,2]. It is shown that personalized and accurate monitoring of MRI lesions and brain atrophy allows the prediction of disability progression, relapses and treatment effect [3]. This work assesses the health economic benefit.

Evaluation

A two scenario decision-tree model is used comparing the situation with and without accurate monitoring of MRI lesions (T2/Gd enhancing and evolution) and brain atrophy. We estimate that yearly 10000 therapy initiations or switches take place in the US, with an average medication cost of $60k [4]. Considering that 26% of these treatments are suboptimal [1] for 3.9 years [5], current costs of failing treatments are about $600M. With an accurate monitoring of MRI lesions and atrophy, the probability to detect treatment failure is 3.1 times higher [6], reducing the average time on suboptimal treatment to 1.3 years. This results in a cost saving of about $400M (67%).

Discussion

In order to realize such a significant cost saving, efforts are required to introduce accurate and reproducible assessments of MRI lesions and atrophy into the radiological reporting [3]. Today, counting lesions and identifying new (and enlarging) lesions is time consuming and prone to variability (intra-rater and inter-rater), and accurately assessing brain atrophy is not even possible by human eye. Automated quantification by software imposes itself as a solution.

SSC12-02 Longitudinal Persistence of Meningeal Enhancement on Post-Contrast 7 Tesla FLAIR MRI in Multiple Sclerosis

Monday, Nov. 27 10:40AM - 10:50AM Room: N226

Awards
Student Travel Stipend Award

Participants
Samuel N. Jonas, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
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PURPOSE

Multiple sclerosis (MS) is a chronic demyelinating disorder associated with increased magnetic resonance signal on T2-weighted sequences within characteristic white matter regions of the brain and spinal cord. Recently, post-contrast FLAIR has emerged as a technique for evaluating meningeal inflammation, an under-recognized facet of MS pathophysiology. We have recently reported the incidence of this finding on 7 Tesla (7T) MRI. In this study, we aimed to determine if the presence of meningeal enhancement on 7T MRI in MS is a transient or persistent phenomenon.

METHOD AND MATERIALS

11 patients with MS were prospectively scanned at two time points, approximately 1 year apart, on a Philips 7T Achieva magnet between September 2014 and May 2016. Magnetization-prepared FLAIR (MPFLAIR) images were acquired at 0.7mm3 resolution before and after administration of 0.1mmol/kg of gadoteridol. Co-registered pre- and post-contrast scans were reviewed by two independent judges: one board certified neurologist and one PGY-3 radiology resident. Foci of meningeal enhancement were annotated using Medical Image Processing, Analysis & Visualization (MIPAV) v. 7.3.0. Discordant lesions that were marked by one but not both judges were reviewed by a third judge: a board certified neuroradiologist. Finalized annotations were classified into 4 subtypes: pachymeningeal nodules (PN), leptomeningeal nodules (LN), subarachnoid amorphous (SA), and dural venous rim (DVR). Follow-up images were then reviewed to determine if they changed between time points.

RESULTS

The median number of enhancing meningeal foci detected per subject on the initial scan was 9 (range 1-15). 86% percent of foci identified on the initial scan were again identified on the follow-up scan; 14% resolved. In 7 of 11 subjects, follow-up scans revealed foci not present on the initial scan. When stratified by morphologic subtype, persistence was observed in 92% PN, 67% LN, 68% SA, and 95% DVR.

CONCLUSION

The majority of enhancing meningeal foci on 7T MPFLAIR are longitudinally persistent in MS. The likelihood of persistence appears dependent on the morphologic features and location of enhancement.

CLINICAL RELEVANCE/APPLICATION

It is critical to determine to what extent meningeal enhancement persists on MRI over time in MS patients, as it will inform future study of the clinical relevance of this phenomenon.

SSC12-03 Edge Density Mapping of Cerebral White Matter in Persons with Cerebral Microbleeds in the Rotterdam Study

Monday, Nov. 27 10:50AM - 11:00AM Room: N226

Participants
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PURPOSE

Cerebral microbleeds reflect presence of small vessel disease and as such are known to be related to white matter disease (hyperintensities and atrophy). Yet, little is known on the overall influence they may have on specific white matter tracts. We studied edge density mapping of white matter in persons with and without microbleeds.

METHOD AND MATERIALS

This study is based on subjects from the population-based Rotterdam Study. Non-demented, stroke-free subjects previously assessed with lobar microbleeds (n = 17) and controls without microbleeds (n = 14) were selected from the larger study population. In all subjects, diffusion tensor imaging (DTI) with 64 directions was available for edge density mapping from a 3T MR Scanner. Edge density images (EDI) were computed from edges involved in a previously defined consensus connectome with each voxel's edge density defined as the number of consensus edges passing through the voxel of interest. To enable comparison between EDI maps of different subjects, EDI maps were registered to MNI152 space. Principal components analysis was done to extract specific EDI maps that separate the microbleed group from control with machine learning using support vector machine learning with leave one out cross validation.

RESULTS

Average age was 64.1 (S.D. 4.5; range 55-73), 45% women. There were no statistically significant differences in age or gender between the microbleed and control group. The microbleed group had an average of 2.43 lobar microbleeds. EDI imaging identified principle components in the posterior corona radiata, splenium of the corpus callosum, and superior longitudinal fasiculus ($p = 10 \times 10\text{-}4$). Figure 1 highlights these three areas in light blue. The area under the curve for these three areas identifying white matter abnormalities on microbleed scans was 87.8%. The sensitivity was 95% and specificity was 70%.

CONCLUSION

Edge density imaging identifies abnormalities in white matter in persons with lobar microbleeds with high accuracy and sensitivity. This suggests the importance of future studies to better elucidate applications of connectome image to vascular brain aging.

CLINICAL RELEVANCE/APPLICATION

Edge density imaging is a new type of connectome mapping that identifies tract-specific white matter abnormalities in persons with cerebral microbleeds. These results suggest this method can identify white matter abnormalities in relation to other brain imaging biomarkers of disease.

SSC12-04 Axial, Radial and Mean Diffusivity in FLAIR-Positive Lesions and Normal-Appearing White Matter in Young Adult Multiple Sclerosis Patients

Monday, Nov. 27 11:00AM - 11:10AM Room: N226

Participants
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PURPOSE

This study investigated axial, radial and mean diffusivity in FLAIR-positive lesions and normal-appearing white matter (NAWM) in young adult MS patients.

METHOD AND MATERIALS

FLAIR and DTI were acquired on 12 relapse-remitting MS patients (18-33yo, 1.5-10 year disease duration, 0-4 EDSS scores) and 12 age- and sex-matched healthy controls at 3T. DTI parameters (axial, radial and mean diffusivity: AD, RD, MD) were calculated. DTI parameters were tabulated for ROIs of the FLAIR positive lesions, NAWM in MS, and corresponding regions in controls. Comparisons were also made with EDSS, disease duration, lesion volume and counts.

RESULTS

In FLAIR positive ("established") lesions, axial, radial and mean diffusivity in MS were significantly higher than controls (AD:1.54±0.22 versus 1.19±0.24, P=0.0002; RD:1.00±0.22 versus 0.73±0.24, P=0.004; MD:1.18±0.22 versus 0.88±0.24, P=0.0008), suggesting edema or cell loss. Covariances of diffusivity data amongst pixels within the ROIs in MS were lower than controls (AD:0.24±0.07 versus 0.40±0.14, P=0.002; RD:0.35±0.06 versus 0.56±0.29, P=0.001; MD:0.28±0.07 versus 0.49±0.21, P=0.004), suggesting reduced tissue heterogeneity. In NAWM, radial and mean diffusivity in MS were significantly smaller than controls (RD:0.58±0.04 versus 0.72±0.04, P=0.001; MD:0.75±0.03 versus 0.83±0.04, P=0.001), but axial diffusivity was not (AD:1.09±0.02 versus 1.08±0.13, P=0.05+). Changes in radial and mean diffusivity suggest early and widespread cytotoxic injury. Covariances of diffusivity data of NAWM in MS were lower than controls (AD:0.31±0.02 versus 0.49±0.13; RD:0.22±0.02 versus 0.44±0.11; MD:0.21±0.02 versus 0.45±0.06, P=0.001 for all), suggesting reduced tissue heterogeneity. DTI parameters were not significantly (P=0.05+) correlated with EDSS, disease duration, lesion volume, and lesion counts.

CONCLUSION

Diffusivity data revealed cell loss in established lesions and cytotoxic injury in NAWM in young adult MS patients. Covariances of diffusivity data corroborated reduced tissue heterogeneity in established MS lesions and NAWM.

CLINICAL RELEVANCE/APPLICATION

DTI diffusivity data provide insights in the pathophysiology of MS in young adults. Diffusivity data may serve as imaging biomarkers of early disease pathophysiology in MS.

SSC12-05 The Relationship Between Brain White Matter Hyperintensity Burden Assessed Ante-mortem and Post-mortem

Monday, Nov. 27 11:10AM - 11:20AM Room: N226

Participants
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PURPOSE

Many studies have used ex vivo MRI to investigate the association of white matter hyperintensity (WMH) burden with age-related

Many studies have used ex-vivo MRI to investigate the association of white matter hyperintensity (WMH) burden with age--related neuropathologies while eliminating the interval between imaging and death (ante-mortem interval, AMI). All such investigations assume that WMH burden assessed ex-vivo is identical to that observed in-vivo, but that has not yet been established. Thus, the purpose of this work was twofold: 1) to investigate the relationship between WMH burden assessed in-vivo and ex-vivo on the same older adults, and 2) to test the hypothesis that WMH burden assessed ex-vivo is higher than that assessed in-vivo for longer AMI.

METHOD AND MATERIALS

83 older adults (90±7 years of age) recruited from two longitudinal, cohort studies of aging, underwent both in-vivo and ex-vivo brain MRI. The average AMI was 2.2±1.5 years. The average post-mortem interval (PMI; from death to immersion in fixative) was 8.1±4.7 hours. The average PMI to imaging was 30 days. A rater trained by an expert assessed WMH severity based on the original Fazekas scale. WMH burden was defined as the maximum of the periventricular and deep white matter WMH ratings. Intra-class reliability and agreement with the expert were assessed. In-vivo and ex-vivo ratings were compared for all participants. Two groups of participants were defined based on whether the WMH burden rating increased from in-vivo to ex-vivo MRI or not (excluding participants that already had the maximum rating in-vivo), and logistic regression of two groups was used to test the hypothesis that increased WMH burden ex-vivo is associated with longer AMI.

RESULTS

Intra-rater reliability (ICC=0.76) and agreement with the expert (ICC=0.80) were both strong. WMH burden generally stayed constant or increased from in-vivo to ex-vivo MRI. Logistic regression showed that for every one year increase in AMI, the odds of greater WMH burden ex-vivo increase by 59% (p=0.04).

CONCLUSION

This study demonstrated no drastic differences between in-vivo and ex-vivo WMH burden, providing strong evidence that WMH burden assessed ex-vivo is of the same nature as WMH burden assessed in-vivo. Any differences observed were probably due to additional pathology developing during the AMI.

CLINICAL RELEVANCE/APPLICATION

This study indicated no drastic differences between in--vivo and ex--vivo WMH, suggesting that WMH ex-vivo may be linked to in-vivo WMH, and thus may be used to assess neuropathological WMH correlates.

SSC12-06 Occupational Hazards of High Flight: A Proposed Mechanism of Neuronal Injury in Pilots and Aircrew Personnel with Hypobaric Exposure

Monday, Nov. 27 11:20AM - 11:30AM Room: N226

Participants
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PURPOSE

Discover cellular mechanisms that lead to cerebral white matter hyperintensities in human pilots following non-hypoxic hypobaric exposure utilizing magnetic resonance spectroscopy (MRS) and arterial spin labeling (ASL). Human exposure to non-hypoxic hypobaria is associated with increased white matter hyperintensities, degradation of axonal integrity, and decrements in neurocognitive processing. The pathophysiologic mechanism underlying this is unknown. We hypothesized that using MRS and ASL could offer insight into cellular changes occurring after acute hypobaric exposure in hypobaric naïve trainees.

METHOD AND MATERIALS

85 U.S. Air Force (USAF) aircrew trainees were evaluated while undergoing their initial occupational hypobaric exposure. Standard USAF procedure is approximately a 30-minute exposure to 25,000 feet. Three high-resolution MR imaging scans were obtained - T-24 hours, T+24 hours, and T+72 hours. Quantitative analysis of ASL and frontal white matter MRS was performed. Fifty-five healthy USAF control subjects meeting the same physical and physiological criteria minus hypobaric exposure served as controls. Paired two-tailed t-tests were used for comparison.

RESULTS

ASL showed an upregulation of both white and gray matter cerebral blood flow at both T+24 and T+72 hours in the exposed subjects (white matter p=0.003/0.020; gray matter p=0.053/0.041) with no significant change in the control's white matter cerebral blood flow. Exposed subjects had a decrease at T+24 in N-acetylaspartate (p=0.065) and myo-inositol (0.027) with no significant change in controls.

CONCLUSION

Significant declines in markers of neuronal integrity suggest that oxidative stress is evident within 24 hours of hypobaric exposure. The increase in cerebral blood flow measured by ASL in subjects exposed to hypobaric conditions is a response to oxidative damage and is evidence of increased metabolic demand. This study provides evidence that white matter hyperintensity formation may occur because of repeated oxidative stress without adequate time for healing. Cerebral white matter hyperintensities in this population are likely a function of both cumulative effects as well as frequency of hypobaric exposure.

CLINICAL RELEVANCE/APPLICATION

Understand the neuropathophysiologic mechanism of hypobaric induced white matter injury in oder to mitigate or prevent its effects upon high altitude pilots and special operations personnnel

SSC12-07 When Pigs Fly: A Swine Model for Study of Hypobaric Non-Hypoxic Exposure Effects on the Brain

Monday, Nov. 27 11:30AM - 11:40AM Room: N226

Participants
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PURPOSE

Non-hypoxic hypobaric exposure in Air Force U-2 pilots and hypobaric chamber personnel is associated with subcortical increased white matter hyperintensities, degradation of axonal integrity, and neurocognitive processing decrements. The mechanism for this is unknown. We developed a swine model to demonstrate and quantify axonal cerebral injury following non-hypoxic hypobaric exposure utilizing advanced magnetic resonance (MR) diffusion tensor imaging, Q-space, and advanced diffusion kurtosis imaging.

METHOD AND MATERIALS

Female miniature pigs (Sus scrofa domestica) were repetitively exposed to non-hypoxic hypobaria at 30,000 feet while controls remained at 5,000 feet altitude. All subjects underwent advanced MRI imaging three times. MR imaging was obtained at baseline, immediately post-exposure, and 4 weeks post-exposure. Advanced diffusion quantification was used to include kurtosis anisotropy, multi-b-value diffusion (Q-space), and fractional anisotropy (FA). Two-tailed t-tests were used for individual and group comparisons.

RESULTS

Perfusion-diffusion index and mean kurtosis anisotropy revealed an increase in unrestricted water immediately after repetitive high-altitude exposures. Repeated imaging at 4 weeks post exposure showed normalization to pre-exposure values. Age-adjusted mean fractional anisotropy (FA) at 4 weeks post-exposure was significantly decreased in the high-altitude group when compared to controls ($p < 0.0001/0.547$).

CONCLUSION

Our study demonstrates increase in unrestricted free water immediately after repetitive high-altitude exposure that is consistent with axonal injury, not seen in the control group. The significant decrease in FA at 4 weeks suggests degradation of axonal integrity. This replicates similar MR imaging findings in humans. This study provides evidence that repetitive hypobaric exposure incites axonal damage. Moreover, it supports the utility of advanced diffusion imaging techniques such as kurtosis anisotropy. To our knowledge, this is the first study to provide evidence that repetitive non-hypoxic hypobaric exposure incites axonal damage, as well as demonstrates our swine model as a feasible vector to study hypobaric neuronal injury and, possibly, other axonal injury processes like TBI.

CLINICAL RELEVANCE/APPLICATION

Understand the neuropathophysiology of hypobaric induced white matter injury in order to mitigate or prevent effects upon aircrew and special operations personnel

SSC12-08 Histologic Validation of MRI-Detected Myelin

Monday, Nov. 27 11:40AM - 11:50AM Room: N226

Participants
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PURPOSE

Myelin detection and monitoring is of great value for diseases such as multiple sclerosis and dementia as well as for follow-up in paediatric patients. However, most MRI methods to measure myelin are challenging to perform in clinical routine. Recently, a model was published, where myelin partial volume in the brain is measured using a rapid quantitative MRI sequence. The purpose of this work was to validate the model with post-mortem histology.

METHOD AND MATERIALS

The brains of 12 fresh, intact cadavers were scanned with a quantification sequence to determine the R1 and R2 relaxation rates and proton density PD, as input for the myelin model. Subsequently, the brains were excised at autopsy and brain slices were stained with Luxol Fast Blue to verify the presence of myelin. The stained brain slices were photographed, converted to optical density and registered with the MRI images. A correlation analysis was performed between the MRI-detected and LFB-stained myelin values.

RESULTS

A correlation was found between the two methods with a mean Spearman's rho for all subjects of 0.74±0.11. Linear regression showed a mean intercept of 1.50±2.84% and a mean slope of 4.37±1.73 %/%. A lower correlation was found for the separate R1 and PD (rho = 0.63±0.12 and -0.73±0.09, respectively). For R2, the rho was very low (0.11±0.28).

CONCLUSION

The observed correlation with post-mortem histology supports the validity of the myelin measurement model using rapid MRI

The observed correlation with post-mortem histology supports the validity of the myelin measurement model using rapid MRI quantification.

CLINICAL RELEVANCE/APPLICATION

The study validated histologically that a single MRI sequence of less than 6 minutes scan time can provide myelin content estimation in the brain.

SSC12-09 Axonal Water Fraction (AWF)-Based Parcellation of the Corpus Callosum: A White Matter Tract Integrity (WMTI) Study

Monday, Nov. 27 11:50AM - 12:00PM Room: N226

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PURPOSE

Despite the corpus callosum (CC) being composed of many different anatomic white matter (WM) tracts, structurally informed intra-callosal parcellation remains a challenge as clear boundaries between WM bundles are difficult to separate. Most previous work relies on gross callosal geometry or operator-dependent manual placement of regions-of-interest. Here we present a method of intra-callosal parcellation based on white matter tract integrity (WMTI) metrics derived from two-compartment modeling of multi-shell diffusion imaging, specifically axonal water fraction (AWF) to attempt to separate CC regions based on axon density.

METHOD AND MATERIALS

21 healthy individuals(34±9 y.o) were scanned using a 3T MR scanner (Skyra, Siemens) under IRB approval. Multi-shell diffusion imaging was performed using 5 b-values (upto 2.5ms/μm2, 60 directions). The CC skeleton was acquired in a fractional anisotropy(FA) template space and was dilated to avoid volume averaging through CSF(Fig.1(top,red)). Subject AWF maps were registered to a template space. AWF values within ROIs were averaged in each coronal slice along the CC. Subdivisions were placed at local maxima of the first derivative(Fig.1(bottom)), demarcating the CC into distinct segments based on greatest degree of change in AWF. We looked at this also: extra-axonal radial diffusivity(De,perp) to see patterns across segmented regions in De,perp reflective of myelination(Fig.2).

RESULTS

Fig.1 shows the plot of AWF along the CC. Its fist derivative plot was used to partition the CC into 5 regions(Fig.1(bottom)). Our results support the work of Hofer and Franhm (Neuroimage,2006) based on tractography from manual ROI placement.

CONCLUSION

WMTI has been proposed to disentangle intra- and extra-axonal environments. This can be leveraged to partition the CC based on AWF, reflective of biophysical factors of the underlying WM microstructure. Specifically, we found relatively lower AWF and higher De,perp in region 4, the posterior callosal body, known to contain a greater number of large diameter axons with thicker myelin. This technique would be easily translatable to individual subjects, even without morphing to a template space and future work is underway in this direction.

CLINICAL RELEVANCE/APPLICATION

Compartment specific *white matter tract integrity* metrics are sensitive to the underlying white matter microstructure and specifically *axonal water fraction* is able to partition the corpus callosum.

RSNA 2017 Explore. Invent. Transform.
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SSC13

Physics (CT: Dual Energy and Spectral CT)

Monday, Nov. 27 10:30AM - 12:00PM Room: S404AB

BQ CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSC13-01 Organ-Specific Context-Sensitive Single and Dual Energy CT (DECT) Image Reconstruction, Display and Analysis

Monday, Nov. 27 10:30AM - 10:40AM Room: S404AB

Participants
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PURPOSE

To combine mutually exclusive CT image properties (reconstruction kernels, monoenergetic reconstruction, dual energy classification or display settings) into a single organ-specific image reconstruction and display.

METHOD AND MATERIALS

Given a CT rawdata set there are manifold parameters for CT image reconstruction and display. To name a few of them: reconstruction algorithm and parameters, dual energy spectral properties and display settings. Often, specific settings are tied to certain organs and thus several reconstructions are required to fully exploit the diagnostic potential of the CT data. We propose a method to locally reconstruct the desired image properties by using an atlas-based context-sensitive reconstruction. Each voxel of the atlas indicates the probability of the voxel belonging to a certain organ. By aligning the atlas onto one target volume, the anatomical structures are automatically segmented and classified into the organs heart, vasculature, liver, kidney, spleen and lung. Moreover, each voxel is assigned to different tissue types (bone, fat, soft tissue and vessels). Reconstruction and display parameters most suitable for the organ, tissue type, and clinical indication are chosen automatically from a predefined set of reconstruction parameters on a per-voxel basis. The approach was evaluated using patient data acquired with a dual source CT system.

RESULTS

Ten contrast-enhanced DECT patient datasets in arterial and portal venous phase were used. We are able to reconstruct each tissue type with the most appropriate kernel by using prior anatomical knowledge. The resulting, context-sensitive enhanced images simultaneously combine the indication specific advantages of different parameter settings without experiencing algorithm related artifacts. A direct comparison with conventionally reconstructed and displayed images revealed no information loss in the compound image. Dual energy overlays or tissue classification information are shown wherever appropriate.

CONCLUSION

With the use of our context-sensitive reconstruction and display approach, the images present significantly more information to the reader simultaneously and dealing with multiple image stacks is unnecessary.

CLINICAL RELEVANCE/APPLICATION

The proposed method improves the clinical workflow and bears the potential to increase the rate of clinically relevant incidental findings.

SSC13-02 Spectral CT Analysis Using Custom Plugins for a Clinical DICOM Viewer

Monday, Nov. 27 10:40AM - 10:50AM Room: S404AB

Participants
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PURPOSE

Spectral CT potentially reduces energy-dependent artifacts and produces more quantitatively accurate images. As recognized early in CT development, this is especially true for spectral CT based on projection-space decomposition using a physics-centric basis set.

METHOD AND MATERIALS

Spectral CT fingerprinting is our term for the statistical analysis of the intrinsic 2D information content for tissue attenuation in all current forms of spectral CT, including dual source and dual layer detector. Since current clinical workflow does not facilitate spectral analysis outside specific applications (ex. iodine maps, fat quantification), we developed novel tools for spectral CT image analysis. pyOsiriX (Blackledge et al,2016) is a recently published plugin for the popular OsiriX (Pixmeo SARL) family of DICOM viewers, including open source variants Horos (horosproject.org) and Osiri-XLV. pyOsiriX facilitates the rapid development of Python-based image analysis, modeling, and interpretation in a clinical-quality DICOM environment. We deployed pyOsiriX-based software tools that interact with Spectral Basis Images (SBIs) from a detection-based spectral CT (IQon, Philips Healthcare), as well as image-space dual source studies (Siemens).

RESULTS

The pyOsiriX Spectral CT Toolbox produces new DICOM series containing scatter plots of the native spectral CT data. We denote these 2D scatter plots as material attenuation decomposition (MAD) plots, with local MAD plots being at the slice level and the global MAD plot for the entire series. The toolkit facilitates bi-directional segmentation between the volume and MAD plots, as well as annotation with libraries of known materials and tissues. Analysis results natively support both ROI tools and multi-planar reformatting. For more complicated tasks, a single slice or entire series can be seamlessly exported to NIH ImageJ/FIJI where analogous scatterplot tools are available alongside an extensive image processing library.

CONCLUSION

The pyOsiriX Spectral CT Toolbox is a robust framework for exploring intrinsic 2D spectral data and provides a more global viewpoint of the spectral CT information content than standard material decompositions and monoenergetic results.

CLINICAL RELEVANCE/APPLICATION

Analysis of spectral CT data using such tools may allow subtle changes in contrast to be better understood in terms of the underlying tissue composition and pathology.

SSC13-03 Investigation on the Repeatability of Coronary Artery Calcium Quantification Using Contrast-Enhanced Dual-Energy Computed Tomography Scans in Comparison with Unenhanced Single-Energy Scans

Monday, Nov. 27 10:50AM - 11:00AM Room: S404AB

Participants
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PURPOSE

To assess the repeatability of coronary artery calcium (CAC) scoring using contrast-enhanced dual-energy (DE) scans and compare it with conventional CAC scores obtained from unenhanced single-energy (SE) CT images.

METHOD AND MATERIALS

Synthetic vessels with iodinated blood (diameters 4 and 4.5mm) containing calcium stenoses (hydroxylapatite) of different sizes and densities were scanned in a chest phantom using a DE coronary CT angiography protocol (90kV/Sn150kV, SOMATOM Force, Siemens) with 3 doses (mAs/CTDIvol: automatic exposure control/7mGy, 160mAs/21mGy and 260mAs/32mGy) and 10 repeats. Images were reconstructed at 3mm slice thickness, with Qr36 kernel, using FBP and ADMIRE-3 (IR). As a control, a set of vessel phantoms without iodine was scanned using a standard SE CAC score protocol (automatic exposure control/3mGy). Calcium volume, mass and Agatston scores were estimated for each stenosis. For DE data, image-based three-material (calcium, iodine, soft tissue)

decomposition was applied to remove iodine before scoring. Calcium scores for 4 stenoses were analyzed (degree of stenosis: 50%, density: 300 and 450HU at 120kV). Within-subject coefficient of variation (wCV) was calculated for each stenosis and imaging condition and across corresponding scores from DE and SE data.

RESULTS

The repeatability of calcium scores varied depending on the size and density of the stenosis: wCV decreased as size and/or density of calcium increased. wCVs for DE based calcium scores were strongly impacted by image noise: higher dose reduced variability and IR outperformed FBP at the same dose level in terms of wCV. The mean wCVs of volume scores of all stenoses for DE dataset with FBP/IR from low to high doses were 0.14±0.08/0.12±0.05, 0.14±0.05/0.08±0.04, and 0.10±0.05/0.04±0.10. Only 260mAs dose level with IR yielded comparable wCV to those from SE data (0.04±0.02). All trends were consistent for volume, mass and Agatston scores.

CONCLUSION

It is feasible to extract calcium scores from contrast-enhanced images using DE based material decomposition methods. However, to achieve similar repeatability of calcium scores to that from conventional unenhanced SE CT images, much higher radiation dose is required.

CLINICAL RELEVANCE/APPLICATION

Although DE based iodine-removal method may eliminate the need for unenhanced SE scans dedicated for CAC score, our findings suggest significantly higher dose is needed to achieve good repeatability.

SSC13-04 Quantification of Cisplatin Concentration by using Material Decomposition Algorithm at 3rd Generation Dual Source Dual-Energy CT: An Experimental Phantom Study

Monday, Nov. 27 11:00AM - 11:10AM Room: S404AB

Participants
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PURPOSE

Intra-arterial infusion or embolization with high-dose cisplatin has been performed following selective angiography for locally advanced head and neck cancer or hepatocellular carcinoma. The purpose of this study was to assess the ability of dual source dual-energy computed tomography (DECT) to quantify cisplatin concentration by using the material decomposition algorithm.

METHOD AND MATERIALS

Fifteen agarose-based phantom syringes that contained various concentrations of iodine (0, 1.0, 2.0 mgI/mL) and cisplatin (0, 0.5, 1.0, 2.0, 3.0 mgPt/mL) were scanned with DECT at 80 kV and Sn150 kV. Cisplatin-specific slope was determined using iodine-free agarose and cisplatin phantoms. Then, cisplatin maps were reconstructed from dual-energy calculation by using three-material decomposition algorithm of agarose, iodine, and cisplatin. HU values from six consecutive images on cisplatin maps were obtained for each phantom by placing regions of interest. The relationships between HU values on cisplatin maps and cisplatin concentration for each iodine concentration were assessed by using Spearman rank correlation coefficient (ρ) and linear regression analyses. To assess the influence of iodine on cisplatin measurements made by using cisplatin maps and cisplatin concentration, the linear regression lines for HU values on cisplatin maps and cisplatin concentrations were compared by using analysis of covariance at three levels of iodine concentration.

RESULTS

Cisplatin maps could identify the lowest cisplatin concentration of 0.5mgPt/mL. Significant linear correlations were found between HU values on cisplatin maps and cisplatin concentrations for each iodine concentration (ρ=0.980-0.981, $P<.001$). At higher iodine concentrations, the linear coefficients for HU values on cisplatin maps decreased. Analysis of covariance showed significant differences between 2.0 mgI/mL and 0 or 1.0 mgI/mL ($P<.001$) and no significant difference between 0 and 1.0 mgI/mL ($P=.068$).

CONCLUSION

Cisplatin maps generated from material decomposition algorithm allow to identify the cisplatin concentration of 0.5mgPt/mL or more. In the presence of 2.0 mgI/mL iodine concentration, cisplatin maps led to underestimation of cisplatin concentration.

CLINICAL RELEVANCE/APPLICATION

Third generation dual source DECT can estimate tissue cisplatin concentration, potentially confirming appropriate high-dose distribution during intra-arterial infusion or embolization with cisplatin.

SSC13-05 Improved X-Map for Acute Ischemic Stroke Imaging Using Non-Contrast-Enhanced Dual-Energy CT

Monday, Nov. 27 11:10AM - 11:20AM Room: S404AB

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PURPOSE

A novel imaging technique ("X-map") has been developed to identify acute ischemic lesions for stroke patients using non-contrast-enhanced dual-energy CT (Noguchi K, et al., Cerebrovasc Dis, 26:34-41, 2017). Using the 3-material decomposition technique, the original X-map ("X-map1") eliminates fat and bone from the images, suppresses the gray matter-white matter tissue contrast, and enhances signals of edema induced by ischemia. There were the following three problems with the X-map1: (1) faint biases near the skull; (2) X-map1 values being qualitative, not quantitative; and (3) presence of many false positives. The aim of this study was to address these problems.

METHOD AND MATERIALS

We improved both an iterative beam hardening correction method (iBHC) and the X-map algorithm. The new iBHC modeled x-ray physics more accurately including off-focal spot radiations. The new X-map ("X-map2") first converted CT pixel values to the truly physics-based characteristic coefficients that are unique to the local tissue materials such as gray matter or white matter. The X-map2 then calculated an increased water density for each pixel, which is called the ischemia index (AISC), with the value of 100 indicating 100% normal tissue (no edema) and 0 indicating 100% water (complete edema).

RESULTS

The new iBHC provided quantitatively accurate pixel values: Pixel values near the skull were biased by 12-to-20 HU with the old iBHC, whereas the bias with the new iBHC was as small as -3-to-2 HU. Performed on the improved iBHC image, the X-map1 presented an ischemic lesion correctly; however, there were suspicious false-positive lesions and the size of the ischemic lesion was smaller than DWI-MRI image. In contrast, the X-map2 provided much fewer false-positive lesions and the correct ischemic lesion size. The extent of the lesion with AISC<90 agreed with the ischemic lesion presented in DWI-MRI.

CONCLUSION

We have improved both iBHC and X-map algorithms. The combined method decreased false positives, improved the agreement with DWI-MRI, and provided quantitative index values.

CLINICAL RELEVANCE/APPLICATION

When acute ischemic lesions, intracranial hemorrhage, and thrombus are identified correctly and confidently, the most effective therapeutic option can be chosen within 45 min of patient arrival.

SSC13-06 Cross-platform Comparison of Lower Limits of Iodine Detection with Single Source, Dual Source, and Rapid Kilovoltage Switching Dual Energy CT Platforms

Monday, Nov. 27 11:20AM - 11:30AM Room: S404AB

Participants
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PURPOSE

To evaluate and compare the accuracy and lower limits of iodine quantification across multiple dual energy CT platforms, including single source, dual source, and rapid kilovoltage switching platforms.

METHOD AND MATERIALS

A commercially available phantom was used to evaluate iodine concentrations of 10, 7.5, 5, 2.5, 2 and 0 mg/ml. As there were no commercially available iodine phantoms below 2 mg/ml, an in-house phantom was developed using serial dilutions of Omnipaque 300 mg/ml to evaluate iodine concentrations of 3, 1.5, 1, 0.6, 0.3, and 0.15 mg/ml. The phantom was scanned on single source (Siemens Definition Edge), dual source (Siemens SOMATOM Force), and rapid kilovoltage switching (GE Revolution HD) CT scanners. Scan parameters were adjusted across platforms to maintain a CTDIvol of approximately 25 mGy, and images were reconstructed at 3 mm thickness. No iterative reconstruction was employed. Images were post-processed and analyzed utilizing the vendors' respective dual-energy workstation platforms, Syngo.via, and GE AW server.

RESULTS

1 mg/mL was the lowest visually perceptible concentration across all platforms. CNR at 1 mg/mL was best (2.7) on the dual source platform with monoenergetic 40 keV images, and improved progressively for all platforms on monoenergetic images as keV settings were lowered. The single and dual source platforms improved in linear fashion, while the rapid kVs platform was best modeled by a polynomial function. Both dual source and rapid kVs platforms demonstrated linear response in measured iodine concentration (R2=0.99). The lowest CNR required to be visually perceptible with optimization of window/level settings and viewing environment was approximately 1.2-1.3. On the rapid kVs platform, the Iodine material basis pair images demonstrated superior CNR to monoenergetic images, even at 40 keV.

CONCLUSION

The lowest iodine concentration that was visually discernible was 1.0 mg/ml across all platforms. The highest CNR achieved at this concentration was 2.7, by the dual source scanner on monoenergetic 40 keV images.

CLINICAL RELEVANCE/APPLICATION

Dual energy CT can accurately quantify iodine concentration across a wide dose-range, down to a minimum of approximately 1 mg/ml, which may allow its use as a quantifiable biomarker.

SSC13-07 Comparing Imaging Performance across Spectral Computed Tomography Platforms

Monday, Nov. 27 11:30AM - 11:40AM Room: S404AB

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PURPOSE

To evaluate the imaging performance across different spectral Computed Tomography (CT) platforms, including: kVp-Switching CT, Dual-Source CT, and Dual-Layer CT.

METHOD AND MATERIALS

A semi-anthropomorphic abdomen phantom for CT performance evaluation was imaged on different spectral CT systems: kVp-Switching (Discovery CT750 HD, GE, United States), Dual-Source (Somatom Definition Flash & Force, Siemens Healthineers, Germany) and Dual-Layer CT (IQon Spectral CT, Philips Healthcare, The Netherlands). Scans were repeated three times for each radiation dose levels (CTDIvol: 10 mGy, 20 mGy and 30 mGy). To be able to better compare results all data were reconstructed in a non-iterative mode and dose modulation was switched off. The phantom was imaged with different extension rings to simulate obese patients and was equipped with a specific spectral insert, which included the following materials: water-, adipose-, muscle-, liver-, bone-like materials and a variation of iodine concentrations. Over the range of available virtual mono-energetic images (VMI) noise as well as quantitative accuracy of VMI Hounsfield Units (HU), and iodine concentrations were evaluated.

RESULTS

Over the range of VMI levels the HUs could be determined with high accuracy when comparing to the theoretical values. For kVp-Switching and Dual-Source CT an increase in noise could be observed towards lower VMI levels. A patient size dependent increase in iodine concentrations error can be observed for all platforms. For a medium patient size the iodine concentration bias was for the three dose levels (CTDIvol: 10 mGy, 20 mGy and 30 mGy): 0.344 mg/ml, 0.348 mg/ml and 0.314 mg/ml (kVp-Switching), 0.741 mg/ml, 0.736 mg/ml and 0.730 mg/ml (Dual-Source), and 0.240 mg/ml, 0.192 mg/ml, and 0.134 mg/ml (Dual-Layer).

CONCLUSION

Iodine concentrations as well as VMI HUs could be accurately determined across different spectral CT systems. In non-iterative reconstruction mode, the noise behaviour of dual-layer CT is independent of the keV VMI level, while an increase in noise is observed for kVp-Switching and Dual-Source CT.

CLINICAL RELEVANCE/APPLICATION

Current high-end spectral CT scanners allow accurate material quantification using different techniques. This should allow to move toward quantitative CT imaging in the clinical day-to-day routine.

SSC13-08 Diagnostic Spectral Image Quality Achievable in Obese Patients Using Detector Based Dual Energy CT

Monday, Nov. 27 11:40AM - 11:50AM Room: S404AB

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PURPOSE

Currently, tube based dual energy CT scanners have limited ability to scan patients with large body habitus due to their low energy limitations. The purpose of our study is to assess the image quality and interpretability of monoE 70 KeV and iodine images obtained on a spectral detector CT scanner (SDCT) in obese patients.

METHOD AND MATERIALS

IRB approved, HIPAA compliant retrospective review of 15 patients over 270 lbs (122.5 kg) who underwent a CT of the abdomen and pelvis using the Philips IQon Spectral detector CT at our institution between December 2016 and March 2017 was performed. Body mass index of the 15 patients ranged from 33.87 kg/m² - 71.48 kg/m² with weights in the range of 271 lbs - 366 lbs. Two fellowship trained, board certified radiologists reviewed the images, specifically the conventional and monoE 70KeV for image quality and graded contrast to noise ratio (CNR) on a five point scale between 1 for conventional imaging superiority to 5 for monoE 70KeV superiority. Iodine map sequences were analyzed for image quality and homogenous interpretability based upon a five point scale (1-5) with 1 being uninterpretable to 5 being completely interpretable.

RESULTS

When comparing the conventional images to the monoE 70KeV images, there was a 100% concordance between the two reviewers that the monoE 70KeV images were superior to conventional images with an average score of 4.57 for reviewer 1 and 4.64 for reviewer 2. In regards to the iodine map, reviewer 1 had an average score 4.07 and reviewer 2 had an average score of 4.57. These values fall between a score of 4 and 5, with 4 being a score where the iodine map is completely interpretable, except for one organ and 5 being a score for iodine maps being completely interpretable. None of the iodine map ratings fell below a score of 3, where the iodine map is interpretable with more than one organ limitation.

CONCLUSION

SDCT scanner permits spectral imaging in obese patients who were previously considered inappropriate for dual energy scanning. MonoE 70KeV provided superior image quality in obese patients as compared to conventional images.

CLINICAL RELEVANCE/APPLICATION

Diagnostic image quality of obese patients can be achieved using the IQon SDCT.

SSC13-09 Feasibility of Dual-Energy CT for Zinc Quantification in an Experimental Phantom Model

Monday, Nov. 27 11:50AM - 12:00PM Room: S404AB

Participants
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PURPOSE

Cumulative evidence indicates that zinc may play a key role in the development of liver and pancreatic cancers. We investigated the feasibility of using dual-energy CT to quantify zinc and to differentiate it from iodine in a phantom experiment.

METHOD AND MATERIALS

Multiple 1.3-cm test tubes were filled with four zinc chloride (2 to 22 mgZn/mL), four iodine (1 to 7 mgI/mL with Iohexol 350 mgI/mL) and two mixed zinc/iodine solutions (75% zinc-to-25% iodine and vice versa), targeting clinically relevant CT numbers on the order of 25 to 150 HU. These were placed into an 85-cm-circumference torso-shaped water phantom, simulating the abdomen of a medium-sized patient. Polyethylene bags filled with vegetable fat were serially wrapped at the periphery of the water phantom to mimic large (110-cm) and extra-large (120-cm) patient sizes. The three phantom sizes were imaged in dual-energy (80/140 kVp, 600 mA) and single-energy (120 kVp) modes using a single-source dual-energy 64-MDCT scanner with fast kV switching. For reference purposes, the same scans were repeated by scanning the plastic test tubes in air. CT radiation output was kept constant for all acquisitions. Material-specific and attenuation information were extracted from raw-data.

RESULTS

A custom linear mixing algorithm was generated from dual-energy monochromatic datasets to obtain zinc maps, which yielded estimates of zinc concentration with RMSE of 0.8 mg/mL across dilution levels and phantom sizes. The lowest 2.8 mgZn/mL solution was measured to have 2.5+/-0.4 mgZn and was significantly higher than Zn estimates in the background (0.2+/-0.6 mgZn, $P<0.001$, 1-sided t-test), demonstrating that trace levels of Zn are detectable. Iodine maps from the commercially-available software yielded a RMSE of 0.5 mgI/mL. The system was unable to reliably discriminate zinc from iodine when both materials were present within the same sample.

CONCLUSION

Dual-energy CT can quantify zinc in an experimental phantom model. Dual-energy may not be able to reliably distinguish between zinc and iodine within the same tissue sample, thus suggesting that a separate dual-energy noncontrast acquisition may be needed for optimized in-vivo zinc quantification.

CLINICAL RELEVANCE/APPLICATION

Non-invasive quantification of zinc with dual-energy CT may prove useful in oncologic imaging as quantitative biomarker for early identification of malignancy and, possibly, for development of targeted therapies.

SSC14

Physics (Diagnostic X-Ray Imaging: Techniques, Radiation Dose)

Monday, Nov. 27 10:30AM - 12:00PM Room: S503AB

PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSC14-01 Improved Detection of Foreign Bodies on Radiographs Using X-Ray Dark-Field and Phase-Contrast Imaging

Monday, Nov. 27 10:30AM - 10:40AM Room: S503AB

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PURPOSE

To investigate whether the detection of foreign bodies (FB) can be improved using dark-field and phase-contrast radiography compared to conventional (transmission) radiographs.

METHOD AND MATERIALS

Experiments were performed using ex vivo pig paws that were prepared with differently sized FB of metal, wood and glass (n=10 each). Paws without FB served as controls (n=30). All images were acquired using an experimental grating-based large object radiography system. A reader study was performed to investigate the diagnostic value of adding dark-field and / or phase-contrast images to transmission images. Five blinded readers (2nd to 4th year radiology residents) were asked to assess the presence or absence of any FB.

RESULTS

Sensitivity for the detection of metal FB was 100% for all readers. The sensitivity for the detection of wooden FB increased from 0-10 % for transmission images to 70-80% when dark-field images were added. For the detection of glass FB, sensitivity increased from 80-100% for transmission images to 90-100% when adding phase-contrast images. Sensitivity for the detection of any foreign bodies was highest when transmission, dark-field and phase-contrast images were viewed simultaneously (87-93%), compared to 60-67% for the sole analysis of transmission images. Specificity was 97-100% across all readers and radiography modalities.

CONCLUSION

Analysis of dark-field images led to a substantially improved detection of wooden FB compared to the sole analysis of transmission images. Detection of glass FB was slightly improved when adding phase-contrast images.

CLINICAL RELEVANCE/APPLICATION

Improved detection of glass and wooden FB on radiographs can facilitate their removal and prevent infectious complications from missed FB.

SSC14-02 Assessing the Relevance of Testing Tube Voltage against the 1kV Remedial or 2kV Suspension Levels in Digital Mammography

Monday, Nov. 27 10:40AM - 10:50AM Room: S503AB

Participants
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PURPOSE

Current protocols give strict guidelines on remedial and suspension levels for tube voltage accuracy. This work examines whether breaching these limits results in unacceptable image quality in digital mammography.

METHOD AND MATERIALS

Images were acquired on a Siemens Inspiration system using (1) the contrast-detail phantom for mammography (CDMAM), evaluated with cdcom computerized reading, and (2) the 3D structured L1-phantom, containing acrylic beads of different diameters in water and inserted lesions (microcalcifications, spiculated and non-spiculated mass models). Five readers evaluated detectability of the inserts in a four-alternative forced-choice study. Images were acquired under automatic exposure control with tube voltage of 29kV for CDMAM and 30kV for the L1-phantom, and then for 2 lower and 2 higher tube voltage settings. Figures of merit are threshold gold thickness (T) for the 0.1 and 2mm disks for CDMAM and threshold diameter (dtr) for the L1-phantom. Mean glandular dose (MGD) was calculated using the Dance formula.

RESULTS

Threshold diameters (dtr) and their 95% confidence interval were 0.114[0.110-0.118]mm at 30kV for microcalcifications in the L1-phantom. Deviations of -1kV or +1kV did not result in significant changes in dtr, with values of 0.117[very wide]mm and 0.118[0.117-0.119]mm respectively. Likewise for -2kV, dtr was 0.110[0.109-0.112]mm, for +2kV however a slight increase in dtr was found (0.122[0.119-0.126]mm). For spiculated and non-spiculated masses similar results were obtained with dtr ranging from 4.7[4.0-5.5]mm to 4.6[2.9-6.4]mm and from 4.3[3.9-4.8]mm to 4.0[1.7-6.3]mm in going from 28kV to 32kV, respectively. Confidence intervals for T for the 0.1mm as well as for the 2mm disk were overlapping for all tube voltage levels tested. Doses ranged from 0.91 to 1.14mGy for the L1-phantom and from 1.02 to 1.29mGy for CDMAM.

CONCLUSION

Deviations in tube voltage of ±1 and ±2kV, corresponding to current remedial and suspension limits, left image quality figures for calcifications and masses largely unaffected but caused changes in dose of up to 20%.

CLINICAL RELEVANCE/APPLICATION

It is unlikely that exceeding tube voltage limits will result in suspension of a system for image quality reasons. Measuring tube voltage is required for dosimetry.

SSC14-03 Coronary Angiography with a Photon-Counting Detector: Initial Results

Monday, Nov. 27 10:50AM - 11:00AM Room: S503AB

Participants
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PURPOSE

To evaluate the potential of coronary angiography with a spectral photon-counting detector as an alternative to digital subtraction angiography (DSA).

METHOD AND MATERIALS

The coronary arteries of a whole pig heart were imaged with a spectral photon-counting detector after injection of contrast material (Ultravist-370, Bayer Healthcare, Germany). The photon-counting detector (Dectris Ltd., Baden, Switzerland) allows the separation of a polychromatic x-ray spectrum into four distinct energy bins. For this experiment the thresholds of the energy bins were placed at 35, 48, 55 and 66 keV. The heart has been imaged with the following parameters: 90 kVp with 4 mm aluminium filtration, 24 mAs and SID of 165 cm. To generate an iodine only image from a single acquisition, the data were decomposed into basis material line-integrals of iodine and soft tissue equivalents by an in-house developed algorithm.

RESULTS

The combination of a spectral photon-counting detector and material decomposition allowed to generate an iodine only image (featuring only the vascular structures) and a soft tissue image. Especially small vessels, which are previously hidden by the soft-tissue, could be clearly visualized. Compared to a conventional image, the contrast between vessels and soft-tissue is enhanced under the penalty of increased image noise. This increase is due to anti-correlated noise, which is common for any spectral imaging technique. Proper handling of the anti-correlated noise by an in-house developed dedicated de-noising algorithm, resulted in a superior contrast-to-noise ratio of the iodine only image (14.47) compared with the conventional image (9.66).

CONCLUSION

Spectral photon-counting angiography allows in a single acquisition to generate iodine only images. Current DSA techniques allow

high-contrast imaging of coronary arteries, however, require two consecutive acquisitions. The proposed technique provides similar contrast quality with a single acquisition and eliminates the possibility of motion artefacts which are common in DSA imaging.

CLINICAL RELEVANCE/APPLICATION

Spectral photon-counting detectors extend the possibilities of X-ray coronary angiography, which already is an invaluable tool for the diagnosis of heart diseases.

SSC14-04 Pixel Size Has No Measurable Influence on Detection and Identification of Bone Abnormalities in Hand Radiographs

Monday, Nov. 27 11:00AM - 11:10AM Room: S503AB

Participants
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PURPOSE

To evaluate the influence of pixel size on detection and identification of bone abnormalities on hand radiographs obtained from a digital flat-panel.

METHOD AND MATERIALS

Radiographic images of the hands were acquired in 50 patients with proven rheumatoid arthritis using a high-resolution detector (85 µm pixel). A dedicated software was developed to generate, from the high-resolution image, a set of images with pixel sizes ranging from 100 to 200 µm. Image zoom was then adapted in order to standardize image size presentation on a workstation whatever the pixel size. The set of images with variable pixel size were randomly distributed into 3 reading sessions and read independently by 3 experienced musculoskeletal radiologists. Each radiologist was asked to draw a box (ROI) around each abnormality detected in the metacarpo-phalangeal joints and to classify it among 3 predefined types, namely erosions, demineralization and geodes. Finally, 2 radiologists reviewed during a consensual reading all the abnormalities mentioned by any of the 3 readers to decide if each abnormality was actual and review its classification. The results of each separate reading were then compared to those of the consensual reading in order to compute both detection rate (presence/absence) and identification rate (image type) of each reader for each pixel size.

RESULTS

Detection probability is close to 40 % for any of the 3 readers and surprisingly barely depends on pixel size within the range from 85 to 200 µm. However, once detected, an abnormality has a high probability (close to 80%) of being correctly identified. Again, no significant influence of the pixel size was found.

CONCLUSION

Besides mammography and dental, hand radiograph in rheumatic diseases is the most demanding in terms of need for fine detail detection. However, no impact of the pixel size in the 85-200 µm range was found on lesion detection and identification.

CLINICAL RELEVANCE/APPLICATION

The quality of clinical diagnosis in hand radiography shows no improvement when pixel size decreases from 200 µm to 85 µm.

SSC14-05 Performance Assessment of a Clinical X-Ray Angiography Detector with Low Electronic Readout Noise

Monday, Nov. 27 11:10AM - 11:20AM Room: S503AB

Participants
Kenneth A. Fetterly, PhD, Rochester, MN (*Presenter*) Nothing to Disclose

PURPOSE

For x-ray angiography systems, detector electronic readout noise results in sub-quantum-limited performance at low x-ray dose levels, compromises image quality, and limits the ability to reduce patient fluoroscopy dose rates to very low levels. The purpose of this work is to assess performance of a new clinical x-ray angiography detector with low electronic noise.

METHOD AND MATERIALS

The MTF, NPS, and DQE of a standard and low electronic noise angiography detectors were measured over the dose range 2.6 to 65 nGy per frame. The pixel pitch of the standard and low noise detectors was 0.184 and 0.164 mm, respectively and both detectors had crystalline CsI scintillators. X-ray generation was controlled manually and the NPS of electronic noise only was measured using dose 0 nGy per frame. The 81 kVp x-ray beam incident to the detector was filtered with 0.3 mm Cu and attenuated with 6.35 cm Al. MTF was calculated from an image of a 1.0 mm Cu edge positioned at a slight angle with respect to the pixel matrix. Areal NPS was calculated from 100x100 pixel regions of interest from 50 frames acquired with rates 7.5, 15, and 30 s-1. Spatio-temporal NPS was calculated to assess lag. Mean photon fluence 34 mm-2 nGy-1 (~1 pixel-1 nGy-1) was use to estimate DQE.

RESULTS

The pixel value versus dose response of both detectors was linear with gain ~4.8 nGy-1. The MTF of the standard detector was higher than that of the low noise detector. NPS measurements demonstrated that the electronic noise of the standard detector was equivalent to ~5 nGy x-ray quantum noise whereas that of the new detector was ~0.5 nGy equivalent. That neither detector

demonstrated lag is consistent with the short decay time of the scintillators. The two detectors had equivalent quantum-limited low frequency DQE which did not vary with frame rate. Whereas electronic noise compromised DQE of the standard detector for dose less than ~15 nGy per frame, DQE of the new detector was quantum-limited for dose as low as 2.6 nGy.

CONCLUSION

In contrast to the standard detector for which electronic noise compromises DQE for per frame dose less than ~15 nGy, the low electronic noise detector demonstrated quantum-limited performance to very low radiation dose levels.

CLINICAL RELEVANCE/APPLICATION

The low electronic noise detector may facilitate very low radiation dose rate fluoroscopic imaging for a variety of clinical indications for both pediatric and adult patients.

SSC14-06 How Important Is the Quality of the Medical Display in Dental Radiology?

Monday, Nov. 27 11:20AM - 11:30AM Room: S503AB

Participants
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CONCLUSION

The quality of the display has an important impact on perceived image quality, visibility of important anatomical features and inter- and intra-observer variability. A medical display scores significantly better on these aspects compared to a consumer display.

Background

Over the past decade, dental imaging has grown significantly as the prevalence of oral diseases worldwide has increased and there is an expanded awareness of oral health. Analog dental imaging systems that utilize cassettes, film and intensifying screens are rapidly being replaced by digital systems where images are visualized on displays. In general radiology the importance of a high quality medical display has been widely accepted, but in dental applications often consumer level displays are still being used. Some countries such as Germany (DIN 6868-157) have passed legislation to impose minimum quality requirements for dental displays. This paper aims at understanding the importance of the display system is in the overall dental imaging chain.

Evaluation

A retrospective reader study was performed. 16 cases of 4 different modalities (Intraoral radiography; Panoramic radiography; Cone-Beam CT; Cephalometric skull radiography) were read by 4 observers on two different displays. The first display was a medical display (Barco Nio Color 3MP; resolution 2048x1536, 1400:1 contrast, 500 cd/m² brightness) and the second display was a consumer display (Dell Ultra Sharp 24 inch; resolution 1920x1080, 1000:1 contrast, 250 cd/m² brightness). Readers answered questions about image quality and visibility of anatomical features using a 7-point scale.

Discussion

Pooled over the 4 different modalities the medical display scored higher than the consumer display with statistical significance. Observers judged the medical display as having better image quality and easier to perceive important anatomical structures. Also a statistically significant advantage was found in favor of the medical display for each modality individually. When analyzing inter- and intra-observer variability it was found that using a medical display reduced variability and increased reading consistency. This result was also statistically significant.

SSC14-07 Optimizing Infant Osseous Survey Techniques for a Digital Radiography Portable

Monday, Nov. 27 11:30AM - 11:40AM Room: S503AB

Participants
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Daniel Vergara, MS, Birmingham, AL (*Abstract Co-Author*) Nothing to Disclose
Ramses Herrera, Birmingham, AL (*Abstract Co-Author*) Nothing to Disclose

CONCLUSION

Programming and posting an infant osseous survey chart has decreased the kVp and the exposure indices used for radiography of infants in our neonatal and continuing care nurseries.

Background

During routine quality control image review, a manager noticed an infant leg imaged with 70 kVp and 5 mAs (deviation index +12.7), and he requested a physicist develop an infant osseous survey technique chart for the relatively new Carestream Revolution DRX digital radiography (DR) portable in the neonatal nursery. From our work on neonatal chest and abdomen exams last year, we had some Lucite and Cornish hen phantom studies, and for this bone project, we obtained additional data with Lucite and aluminum phantoms, line-pair phantoms, and a low-contrast phantom, the UAB Fluoro Test Tool (Fluke Model 07-645). We also reviewed 200 images of bone exams of infants weighing between 1095 and 7945 grams (premature infants to 9 months old), noting their image quality as well as the Carestream exposure index (relative x-ray exposure).

Evaluation

The line-pair phantoms and low-contrast phantom were imaged under thicknesses of Lucite appropriate to the thicknesses of these

infants (5.5 to 15 cm, AP and lateral), and they appeared the most clear with 40 to 55 kVp, with specific voltages preferred for specific thicknesses. These phantom studies, along with prior Cornish hen and Lucite phantom studies, also yielded a range of mAs for each kVp and phantom thickness that produced images within our target exposure index range. We then correlated infant bone exams by body part thickness, kVp, mAs, and exposure index, to further narrow our desired technique ranges.

Discussion

The infant osseous survey chart was first posted a month ago, and fifty infant bone images have been acquired since then. Only one of these images exceeded our target exposure index range; the previous month, eleven of 29 infant bone images exceeded our target exposure index range.

SSC14-08 Dose Reduction to the Lens of the Patient's Eye when Using Small Lead Shields over the Temporal Region of the Head and its Effect on Image Quality for Neuro Cone-Beam Computed Tomography (CBCT) Scans and Interventional Fluoroscopic Procedure

Monday, Nov. 27 11:40AM - 11:50AM Room: S503AB

Participants
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PURPOSE

The purpose of this study was to evaluate the effectiveness and feasibility of placing small lead shields over the thin bone in the temple region of the skull to reduce radiation dose to the lens of the eye during CBCT scans and interventional fluoroscopically-guided procedures of the head.

METHOD AND MATERIALS

EGSnrc Monte Carlo software modeled the x-ray source of a C-arm fluoroscope and was used to determine the lens dose for single x-ray projections and CBCT scans (different kVps and protocols) for the Zubal computational head phantom, which is based on a CT scan of an adult male whose eye lenses were individually segmented. The eye lens dose was calculated without and with small lead patches of different thicknesses placed over the temporal region. Also CBCT scans were taken with a clinical C-arm system on anthropomorphic head phantoms with lead patches, 0.1 mm to 0.3 mm thick, and the images were compared to assess the effect of the shields on image quality.

RESULTS

For single lateral x-ray projections, a 0.1 (0.3) mm thick lead patch reduced the dose to the left-eye lens by 40%-60% (55%-80%) from 45° to 90° RAO and to the right-eye lens around 30% (55%) from 70° to 90° RAO. For the low, middle and high frame-number CBCT protocols, the reduction of lens dose with 0.1 (0.3) mm thick lead patch is 11.3% (20.3%), 22.2% (40.7) and 27.4% (53.2%) at 110 kVp, respectively. Moreover, the reduction of lens dose with a 0.1 mm thick lead patch decreases from 26% to 21% when the tube peak voltage increases from 90 kVp to 120 kVp for the middle frame-number protocol. For the anthropomorphic phantom CBCT scans, the lead patch introduces streak artifacts that are primarily evident in the orbital region but insignificant in the brain region where most neuro-interventional activity occurs.

CONCLUSION

The use of small lead shields placed over the temple region of the head can reduce the patient's dose to the eye lens considerably without significantly compromising image quality in neuro imaging procedures.

CLINICAL RELEVANCE/APPLICATION

A simple method is presented to reduce the patient's lens dose and thus the risk of cataract induction for neuro-interventional procedures.

SSC14-09 Simulation of Microcalcifications for a Breast Phantom Made through Inkjet Printing

Monday, Nov. 27 11:50AM - 12:00PM Room: S503AB

Participants
Lynda C. Ikejimba, PhD, Silver Spring, MD (*Presenter*) Nothing to Disclose
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CONCLUSION

A new type of method was developed to create a breast phantom with realistic microcalcifications through inkjet printing. With a range of MC detectability, the phantom can be used for regular QC and for observer studies.

Background

Breast phantoms serve as an integral part of assessing clinical systems as part of ongoing quality control (QC) as well as for conducting reader studies. Existing breast phantoms may comprise materials with unrealistic properties, or simulate breast structure that is not fully anthropomorphic. This work presents the use of novel materials with inkjet printing to simulate the fibroglandular, adipose, and microcalcification (MC) tissues of the breast, in order to create realistic phantoms for use in QC and reader studies

Evaluation

A digital voxelized breast phantom was first generated using analytical expressions, modelled after a breast with 27% glandular density. Inkjet printing was then used to realize the phantom. To print the fibroglandular-mimicking components, pigmented ink doped with iohexol was created, and printed onto an adipose background consisting of parchment paper. To simulate the MCs, two approaches were taken. For the first, an ink was made by dissolving potassium iodide (KI) salt into a mixture with pigmented ink. For the second, disks of hydroxyapatite, the main component in certain MCs, were created from powder via mechanical press, then crushed, sieved, and placed in a stencil with regular pentagon patterns. Both effective and linear attenuation coefficients of the various materials were measured on a clinical mammography system and by using energy dispersive x-ray spectroscopy systems, respectively.

Discussion

As expected, the linear attenuation of the hydroxyapatite closely modeled that of real MCs. The effective linear attenuation of the KI ink alone was sufficiently high as well, with a single layer of ink. The signal strength can be increased by printing over the signals multiple times, or decreased by reducing the concentration of the salt. Signals of varying strength would be used to achieve different levels of MC difficulty in the phantom.

SSC16

Vascular Interventional (IO-Liver Cancer)

Monday, Nov. 27 10:30AM - 12:00PM Room: E352

GI IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Juan C. Camacho, MD, Charleston, SC (*Moderator*) Nothing to Disclose

Sub-Events

SSC16-01 Investigation of Risk Factors for Primary Treatment Failure and Local Recurrence after Radiofrequency Ablation and Microwave Ablation for Hepatocellular Carcinoma

Monday, Nov. 27 10:30AM - 10:40AM Room: E352

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Our study's aims were to 1) compare treatment response between radiofrequency ablation (RFA) and microwave ablation (MWA) for hepatocellular carcinoma (HCC) and 2) identify tumor characteristics associated with treatment failure and time-to-local recurrence.

METHOD AND MATERIALS

Patients with HCC treated with percutaneous RFA or MWA between January 2007 and June 2016 were reviewed. Tumor size and location, Child-Pugh score and Barcelona Clinic Liver Cancer (BCLC) stage were abstracted. Complications were characterized by SIR criteria and primary efficacy was determined using mRECIST on CT or MRI performed 4-8 weeks after ablation, with secondary efficacy determined similarly after retreatment. Predictors of treatment failure (residual disease) and time-to-recurrence were analyzed using logistic regression and Cox regression analysis, respectively. Follow-up was censored at time of repeat HCC-directed therapy, including liver transplant.

RESULTS

Local ablative therapy, including 104 RFA and 68 MWA, was performed in 145 patients with 152 unique masses. Tumor stages included 29 (19%) BCLC stage 0 and 123 (81%) BCLC A HCC. Tumor diameters were <2 cm in 82 (54%) HCC, 2-3 cm in 50 (33%), and >=3 cm in 20 (13%) cases. HCC were within 5 mm of a blood vessel in 35 (23%) cases. There were 4 (3%) major and 15 (9%) minor complications. Of 144 HCC with imaging to assess response, primary efficacy was achieved in 119 (83%) cases and secondary efficacy in 128 (89%) tumors. Tumor diameter, vascular proximity, and method of ablation (RFA or MWA) were not associated with treatment failure; however performing biopsy at time of ablation was associated with treatment failure (RR=3.2, 95% CI: 1.2-8.9, P=0.02). There were 24 (19%) local recurrences, with median time to recurrence of 25 months (95% CI=20-29 months). Treatment modality was not associated with time-to-recurrence, but HCC diameter >=3cm was associated with shorter time-to-recurrence (HR=3.9, 95% CI=1.4-10, P=0.003).(Figure)

CONCLUSION

Percutaneous RFA and MWA had similar efficacy and time to local recurrence. Performing biopsy at the time of ablation was associated with lower efficacy and tumors larger than 3 cm were associated with local recurrence.

CLINICAL RELEVANCE/APPLICATION

Performing a biopsy at the time of procedure may decrease the efficacy of local ablative therapies.

SSC16-02 Image-Guided Intratumoral Hyperthermia-Enhanced Chemo-Destruction of Radiofrequency-Ablated

Hepatic Tumor Margins

Monday, Nov. 27 10:40AM - 10:50AM Room: E352

Awards
Trainee Research Prize - Fellow

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PURPOSE

To explore the opportunity using radiofrequency ablation (RFA)-associated peritumor hyperthermia (RFH) to specifically enhance doxorubicin (Doxo) destruction of residual tumor cells at margins of ablated hepatic tumors.

METHOD AND MATERIALS

This study included in-vitro experiments with VX2 tumor cells and in-vivo validation experiments by creating New Zealand white rabbit models of liver VX2 tumors. Both in-vitro and in-vivo experiments were divided into four groups with different treatments of (i) combination therapy of Doxo (13.9mM) plus RFH at 42? for 20min or intratumor-injected Doxo (4mg/Kg) plus RFA at 65? for 10 min; (ii) RFH-RFA alone; (iii) Doxo alone; (iv) saline. Therapeutic effect on cells was evaluated by confocal microscopy, MTS assay and apoptosis analysis (n=6 per group). In in-vivo experiments, hepatic VX2 tumors in 12 rabbits were created via a laparotomy, and the created hepatic tumors were treated by using a multipolar perfusion-thermal RFA electrode system, which could simultaneously deliver Doxo specifically to the RF ablated tumor margin zones under fluoroscopy and ultrasound guidance. Ultrasound imaging was used to follow the tumor growth over times, and imaging findings were correlated by subsequent histological confirmation.

RESULTS

Of in-vitro experiments, laboratory examinations demonstrated the lowest cell proliferation (53.47±2.01 vs 92.03±2.24 vs 76.23±3.80 vs 100%, p<0.01), the highest apoptotic index (21.08±3.05% vs 2.67±0.59% vs 12.1±2.34% vs 1.43±0.37%, p<0.01), and the decreased survival cells in combination therapy, compared with three control therapies. Of in-vivo experiments, ultrasound imaging further showed the smallest tumor size with combined therapy compared with other three groups (1.29±1.10 vs 1.69±0.05 vs 1.81±0.13 vs 2.01±0.07), which were confirmed by histological examinations.

CONCLUSION

This study indicates the possibility of using RFA-associated peritumor RFH in enhancing the effectiveness of intratumoral chemo-destruction of RFA-treated tumor margins, which may enable us to develop a new interventional oncology technique to eliminate the high recurrence incident post RFA in treating the patients with solid liver malignancies.

CLINICAL RELEVANCE/APPLICATION

Our study may be developed as an alternative to target theresidual tumor cells in the margin of RF ablated liver cancer.

SSC16-03 Early Response Assessment by Diffusion-Weighted MR Imaging versus PET/CT for Prediction of Survival of Patients Undergoing Y90-Radioembolisation of Hepatic Metastases

Monday, Nov. 27 10:50AM - 11:00AM Room: E352

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PURPOSE

To investigate whether evidence of early response 4-6 weeks after lobar Y90-treatment in Diffusion-weighted liver-MRI (DW-MRI) provides prognostic information, and how it compares to information provided by PET/CT or established oncological factors known to impact survival.

METHOD AND MATERIALS

IRB-approved prospective intra-individual comparative study on 36 consecutive patients (25 female) with liver metastases (20 colorectal, 14 breast, 2 other) aged 60 ± 10 years who underwent 18FDG-PET/CT and DWI-MRI before and early (4-6 weeks) after Y90-RE. Kaplan-Meier-curves and log-rank-test as well as multivariate cox-regression-analyses were used to compare patients' survival depending on response detected by DW-MRI vs. PET/CT, and depending on established variables such as pre-treatment ECOG-performance-status (0 vs. 1), hepatic tumor-load (<25% vs. >=25%), or presence vs. absence of extra-hepatic disease.

RESULTS

35 patients were followed until their death, one is alive 125 weeks after treatment. Median survival was 36 weeks. Response was observed by PET/CT in 18/36 patients (50%). Median survival in PET-responders vs. non-responders was 39 vs. 27 weeks (p= 0.60). Response was observed by DW-MRI in 24/36 patients (67%). Median survival in DWI-responders vs. non-responders was 53 weeks vs. 20 weeks (p = 0.01). At multivariate analysis, response based on DWI was the only independent prognosticator of survival (p < 0.01). ECOG-performance-status, hepatic tumor-load, and presence of extrahepatic metastases did not correlate with survival.

CONCLUSION

In patients with hepatic metastases undergoing Y90-RE, early response detected by DW-MRI provides prognostic information that goes beyond what is obtainable from common clinical criteria, and that is superior to PET/CT.

CLINICAL RELEVANCE/APPLICATION

Response assessment for patients undergoing RE should preferably be done by DW-MRI.

SSC16-05 Combined Therapy of TACE and RFA vs Surgical Resection for Single 2 to 3 Cm HCC: A Propensity Score Matching Analysis

Monday, Nov. 27 11:10AM - 11:20AM Room: E352

Participants
Hyo-Jae Lee, Gwang Ju, Korea, Republic Of (*Presenter*) Nothing to Disclose
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PURPOSE

To compare therapeutic outcomes between radiofrequency ablation (RFA) combined with transcatheter arterial chemoembolization (TACE) and surgical resection (SR) for treatment of HCC ranging from 2 to 3 cm in size which is coming under Barcelona Clinic Liver Cancer class A disease.

METHOD AND MATERIALS

From January 2009 to March 2016, 70 patients (47 men, 40-90 years) underwent combined therapy of TACE and RFA and 84 patients (69 men, 36-81 years) underwent SR. The average tumor size was 2.6 cm ± 3.4, ranging from 2 to 3 cm. Local tumor progression (LTP), intrahepatic distant recurrence (IDR), disease-free survival (DFS), and overall survival (OS) rates were compared between two groups before and after applying propensity score matching. Major complications and length of hospital stay were compared.

RESULTS

During follow-up, LTP had developed in 9 of 70 (12.9%) patients in combined group and in 7 of 84 of (8.3%) in SR group (P = .262). IDR was identified in 24 of 70 (34.3%) in combined group and in 24 of 84 (28.6%) in SR group (P = .252). 1-, 3-, 4-, and 5-year DFS rates were similar between two groups (82.6%, 53.2%, 53.2%, and 37.6%, respectively vs. 84.5%, 63.6%, 59.2%, and 52.1%, respectively; P = .278), and 1-, 3-, 4-, and 5-year OS rates were also similar (94.2%, 81.2%, 74.1%, and 59.4%, respectively vs. 95.2%, 86.3%, 84.0%, and 80.3%, respectively; P = .081). After propensity score matching (n = 98), LTP, IDR, DFS, and OS rates still showed no significant differences between two groups (P = .725, P = .826, P = .484, and P = .578, respectively). The major complication rate was not significantly different between two groups (P = .596). The length of hospital stay was significantly longer in SR group (P = <.001).

CONCLUSION

Before and after propensity score matching, there were no significant differences in long-term therapeutic outcomes between combined and SR groups. In addition, combined therapy of TACE and RFA is relatively safer rather than SR. Therefore, combined therapy of TACE and RFA may be used in lieu of SR for single 2-3 cm HCC with potentially similar outcomes.

CLINICAL RELEVANCE/APPLICATION

In clinical practice, combined therapy of TACE and RFA maybe preferred over SR for treatment of 2 to 3 cm HCC for several reasons, such as limited liver function or concern for surgical complications. However, there are few evidence of therapeutic outcomes for single 2 to 3 cm HCC solely between combined therapy group and SR group.

SSC16-06 Combined Treatment, TACE and Microwave Ablation in Patients with HCC

Monday, Nov. 27 11:20AM - 11:30AM Room: E352

Awards
Student Travel Stipend Award

Participants
Mohamed M. Zaitoun, MBChB , Zagazig, Egypt (*Presenter*) Nothing to Disclose
Saeed B. Elsayed, MD, Zagazig, Egypt (*Abstract Co-Author*) Nothing to Disclose
Sameh Saber, Zagazig, Egypt (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare the feasibility and benefit of combined therapy (TACE+MW ablation) versus TACE or microwave ablation alone in the treatment of HCC larger than 3 cm and smaller than 5 cm

METHOD AND MATERIALS

During 3 years, 150 consecutive patients with HCC larger than 3 cm and smaller than 5 cm were divided into 3 groups, group (1) 50 HCC patients underwent TACE, group (2) 50 HCC patients underwent MW ablation and group (3) 50 HCC patients received combined therapy with TACE followed by MW ablation after 1 month. Mean age was 57 years, 94 (62.7%) were males. Follow up with Triphasic CT was performed after 1 month then every 3 months for 1 year.

RESULTS

After 1 month, complete response was detected in 27 cases (54%) in group (1), 22 cases (44%) in group (2) and 50 cases (100%) in group (3) ,partial response in 8 cases (16%) in group (1), 5 cases (10%) in group (2) and progressive disease in 15 cases (30%) in group (1) and 23 cases (46%) in group 2. Recurrence rate after 1 year was 38 cases (72%) in group (1), 40 cases (80%) in group 2 and 9 cases (18%) in group 3. Disease free survival rate at 12 months was 12 cases (24%) in group 1, 10 cases (20%) in group 2 and 41 cases (82%) in group 3.

CONCLUSION

Combined therapy (TACE+MW ablation) in HCC larger than 3 cm and smaller than 5 cm is better than TACE or RF ablation alone concerning the recurrence rate and disease free survival rate.

CLINICAL RELEVANCE/APPLICATION

(dealing with combined treamtment of HCC) 'TACE with microwave ablation is better than each modality alone in the treatment of HCC.'

SSC16-07 Stratification and Prognosis for Advanced-Stage Hepatocellular Carcinoma Treated with TACE Monotherapy or TACE Plus Sorafenib

Monday, Nov. 27 11:30AM - 11:40AM Room: E352

Participants
Binyan Zhong, MD, PhD, Nanjing, China (*Presenter*) Nothing to Disclose
Caifang Ni, MD, PhD, Suzhou, China (*Abstract Co-Author*) Nothing to Disclose
Gao-Jun Teng, MD, Nanjing, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

We aim to compare the efficacies between transarterial chemoembolization (TACE) monotherapy and TACE plus sorafenib in patients with advanced-stage hepatocellular carcinoma (HCC) as well as to establish a prognostic prediction model to determine who will benefit from the TACE monotherapy.

METHOD AND MATERIALS

This multicentric retrospective study included 169 (115 in training cohort and 54 in validation cohort) patients with advanced-stage HCC (Barcelona Clinic Liver Cancer stage C) between January 2010 and December 2014. In training cohort, 77 (67.0%) underwent TACE monotherapy (TACE group), and the remaining 38 (33.0%) patients received TACE plus sorafenib (combination group). Among them, in TACE group, independent risk factors associated with prognosis were identified by univariate and multivariate analyses and a prognostic prediction model was established to find out who will benefit from TACE monotherapy. Also, a prognostic nomogram for patients in TACE group was created.

RESULTS

In training group, the median overall survival (OS) of the patients in TACE group was significantly shorter than those in combination group (7.7 months vs. 13.9 months; P <0.001). In TACE group, portal vein tumor thrombus (PVTT), number of HCC nodules, and Child-Pugh (CP) stage were independent risk factors correlated with OS. The prognostic prediction (PP) model, PP score = PVTT (0 if no, 5 if branch invasion, 6 if main invasion) + number of nodules (0 if 1, 4 if 2-3, 5.5 if >3) + CP stage (0 if A, 4 if B). Patients with PP score <5.25 had a significant longer OS than those with PP score >5.25 (13.9 months vs. 6.5 months; P <0.001). Also, a prognostic nomogram for these patients was created. Both of the two prediction model received a high accuracy when validated in validation cohort, with the concordance index of 0.858.

CONCLUSION

Advanced-stage HCC patients with PP score <5.25 may benefit most from the TACE monotherapy.

CLINICAL RELEVANCE/APPLICATION

Patients with advanced-stage HCC and with PP score <5.25 may benefit most from the TACE monotherapy instead of TACE combined with sorafenib, which might avoid sorafenib-related adverse events and high cost of sorafenib.

SSC16-08 Clinical Results of a Phase I First in Man Study of Targeted Delivery of Lyso-thermosensitive Liposomal Doxorubicin by Extracorporeal Focused-Ultrasound Hyperthermia for Liver Tumours

Monday, Nov. 27 11:40AM - 11:50AM Room: E352

Participants

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PURPOSE

To determine the safety, feasibility and efficacy of targeted delivery of a lyso-thermosensitive liposomal drug in combination with localised non-ablative hyperthermia delivered non-invasively by extracorporeal focused-ultrasound (FUS).

METHOD AND MATERIALS

Patients with primary or secondary liver tumours unsuitable for curative or radical treatment but amenable to potential ultrasound-guided intervention were assessed for eligibility. A single treatment cycle of Lyso-Thermosensitive Liposomal Doxorubicin (ThermoDox®) was combined with FUS to target a single liver tumour using an ultrasound-guided extracorporeal FUS device (Model JC200, Haifu Medical).Treatments were performed under general anaesthetic. Under ultrasound-guidance a co-axial needle was placed into the target tumour to enable interchange of thermometry device and biopsy needle, utilised for measurement of tumour temperature and tissue sampling. FUS parameters (power, duty cycle, transducer motion) were optimised during treatment to achieve bulk intratumoral hyperthermia (40-44°C).Core biopsies were taken for analysis of total intratumoral doxorubicin concentration by HPLC and drug distribution by fluorescence microscopy. Patients received clinical and radiological follow-up at 2 and 4 weeks.

RESULTS

Ten patients were treated and prolonged hyperthermia was achieved in 5/6 having thermometry. Currently, the measured mean intratumoral doxorubicin post-FUS is 7.58 µg/g (±2.70) (n=4), compared to 2.48 µg/g (±1.26) (n=4) pre-FUS. 6/6 tumours have demonstrated nuclear intercalation of doxorubicin post-FUS, indicating release. PET demonstrated some unequivocal localised response in 5/9 at 2 weeks, despite only a single cycle of ThermoDox® at the standard doxorubicin dose.

CONCLUSION

The combination of lyso-thermosensitive drug delivery systems in combination with non-invasive targeted release by FUS is clinically feasible, safe and can enhance intratumoral drug delivery, leading to targeted and localised PET response, relative to control tumours receiving drug alone.

CLINICAL RELEVANCE/APPLICATION

This study demonstrates safety, feasibility and efficacy of the non-invasive, non-ionising and highly targeted drug delivery method that FUS offers and highlights the potential to exploit this therapy for improved therapeutic outcomes in a broad range of primary and metastatic solid tumours throughout the body, across multiple drug classes.

SSC16-09 Prediction of Post TACE Necrosis of HCC Using Volumetric Enhancement on MR Imaging and Oil Deposition on CT, With Imaging and Pathologic Correlation

Monday, Nov. 27 11:50AM - 12:00PM Room: E352

Participants
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Nanna Shao, MBBS, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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Robert P. Liddell, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Robert Anders, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Ihab R. Kamel, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG
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PURPOSE

To investigate whether volumetric enhancement on baseline MR imaging and oil deposition on unenhanced CT would predict hepatocellular carcinoma (HCC) necrosis and response post conventional TACE (cTACE).

METHOD AND MATERIALS

This HIPPA compliant retrospective study was approved by our institutional review board. The study population included 115 HCC patients (173 lesions) who underwent cTACE with MRI within 3 months before and after cTACE between 2001 and 2015. A subset of 53 HCC patients underwent liver transplant and were defined as LT group. Semiautomatic volumetric segmentation of target lesions was performed at baseline MR, and unenhanced CT post cTACE to assess the accuracy of predicting tumor necrosis after cTACE in the whole cohort and at pathology in the LT group. Predicted volumetric tumor necrosis was calculated as 100% - (%

enhancement on baseline MRI- % oil deposition on CT). Volumetric necrosis on follow up MRI was calculated as (100% - % enhancement in MRI follow-up). Correlation between predicted tumor necrosis and post cTACE volumetric necrosis on follow up MRI in the whole cohort and to percentage necrosis at pathology in the LT group was performed. P value <0.05 was considered significant.

RESULTS

Mean predicted tumor necrosis by combination imaging modalities was 61.5 %±31.6% (range, 0-100%) whereas mean percent tumor necrosis on follow-up MRI was 63.8%±31.5% (range, 0-100%). In the LT group, mean predicted tumor necrosis by combination imaging modalities was 77.6%±27.2% (range, 0-100%) whereas mean percent necrosis at pathology was 78.7%±31.5% (range, 0-100%). There was a strong significant correlation between predicted tumor necrosis and volumetric necrosis on MRI follow-up ($r= 0.889$, $p < 0.001$) and a strong significant correlation between predicted tumor necrosis and pathologic percentage necrosis ($r = 0.871$, $p < 0.001$).

CONCLUSION

Volumetric pre cTACE enhancement in MRI and post cTACE oil deposition in CT may accurately predict necrosis in treated HCC lesions.

CLINICAL RELEVANCE/APPLICATION

This method could potentially be utilized to accurately assess treatment response in HCC patients immediately following cTACE which can be confirmed by follow-up MRI.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ihab R. Kamel, MD, PhD - 2015 Honored Educator

MSRO23

BOOST: CNS-Science Session with Keynote

Monday, Nov. 27 1:30PM - 2:30PM Room: S103AB

NR RO OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Jun Deng, PhD, New Haven, CT (*Moderator*) Nothing to Disclose
Hui-Kuo G. Shu, MD, PhD, Atlanta, GA (*Moderator*) Speakers Bureau, Varian Medical Systems, Inc; Stockholder, General Electric Company; Stockholder, Medtronics plc; Stockholder, Mylan NV ; Stockholder, Apple Inc; Stockholder, ICON plc

Sub-Events

MSRO23-01 Invited Speaker:

Monday, Nov. 27 1:30PM - 1:40PM Room: S103AB

Participants
Hui-Kuo G. Shu, MD, PhD, Atlanta, GA (*Presenter*) Speakers Bureau, Varian Medical Systems, Inc; Stockholder, General Electric Company; Stockholder, Medtronics plc; Stockholder, Mylan NV ; Stockholder, Apple Inc; Stockholder, ICON plc

MSRO23-02 Patient Outcomes after Reirradiation of Small Skull Base Tumors Using Stereotactic Body Radiotherapy (SBRT), Intensity Modulated Radiotherapy (IMRT) or Proton Therapy (PRT)

Monday, Nov. 27 1:40PM - 1:50PM Room: S103AB

Awards
Trainee Research Prize - Fellow

Participants
Sweet Ping Ng, MBBS, Houston, TX (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): The aim of this study is to generate preliminary data for our upcoming institutional phase 2 randomized clinical trial comparing stereotactic body radiation therapy (SBRT) and intensity modulated radiation therapy (IMRT)/proton beam radiotherapy (PRT) for recurrent small skull base tumors.Materials/Methods: Patients who received conformal reirradiation for recurrent small skull base tumors (Results: Of the 53 patients who met the inclusion criteria, 17 (32.1%) received SBRT, 17 (32.1%) received IMRT and 19 (35.9%) received PRT. Fifty (94.3%) patients had an ECOG performance status of 0-1, and 29 (54.7%) had a squamous cell carcinoma histology. The median initial radiation dose was 60 Gy (range: 30 – 74) and median retreatment volume was 25.5 cc (range 2.9 – 59.7 cc). The median reirradiation dose was 66 Gy (range: 50 – 70 Gy) at 2 Gy/Fx daily for IMRT/PRT and 45 Gy (range: 35 – 47.5 Gy) in 5 fractions every other day for SBRT. Thirty eight (71.7%) patients received concurrent chemotherapy with reirradiation. The median time to reirradiation was 30 months (range: 3 – 246 months). With a median follow up of 20 months (range: 3 – 153 months), the LRC, PFS and OS rates were 80.2%, 64.9%, and 88%, respectively at 1 year, and 73.4%, 55.6%, 73.5% respectively at 2 years. Six patients developed Grade 3 late toxicity. One (5.6%) patient received SBRT, 2 (11.2%) received IMRT and 3 (15.8%) received PRT. There were no Grade 4 or 5 toxicities. The 1- and 2-year late Grade 3 toxicity rates were both 6.9%. The median time to develop Grade 3 toxicity was 25.5 months. SBRT and PRT were associated with improved LRC (HR 9.5, 95% CI = 1.55 – 184.66, P=0.01; HR 8.3, 95% CI = 1.51 – 153.29,P= 0.01) compared to IMRT. There was no significant difference in PFS or OS between radiation modalities. There was no difference in ECOG status or histology by radiation modality. Retreatment volume did not significantly correlate with late toxicity rates.Conclusion: Reirradiation of small skull base tumors utilizing IMRT, PRT or SBRT demonstrated good tumor control and low rates of Grade 3 toxicity. A prospective clinical trial and longer follow-up is needed to better assess clinical outcomes and toxicity rates.

MSRO23-03 Stereotactic Radiosurgery (GK-SRS) For the Treatment of Brain Metastasis from Gastrointestinal (GI) Primary

Monday, Nov. 27 1:50PM - 2:00PM Room: S103AB

Participants
Nitika Paudel, MD, PhD, Chicago, IL (*Presenter*) Nothing to Disclose
Thomas Kim, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Rajal Patel, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Liam Kane, BS, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

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ABSTRACT

Purpose/Objective(s): The incidence of brain metastasis in patients with tumors of GI tract is on the rise owing to advancement in imaging and prolonged survival due to improvement in surgical methods, radiotherapy, and systemic chemotherapy. We aimed to

determine the efficacy of GK-SRS to control intracranial metastases from GI primaries and report on the patient outcomes. Materials/Methods: We retrospectively evaluated patients who had undergone GK-SRS at our institution for the treatment of brain metastasis from GI primaries from 2000 to 2016. Actuarial rates for overall survival (OS) and local control (LC) were calculated. The relationship between the various patient characteristics, the clinical, radiographic and treatment outcomes to the rates of local control and overall survival was determined using log-rank analysis.Results: 52 patients met the inclusion criteria with total of 142 intra cranial (IC) lesions. Median age at GK-SRS was 59 years (range 21-84). GI primary sites included colon (28), esophagus (12), rectum (5), liver (3), pancreas (2), bile duct (1) and gallbladder (1). The median treatment dose was 18 Gy (range10-20).The median time from initial diagnosis to detection of CNS metastases was 19 months (range 0-188). The median Karnofsky Performance Status (KPS) at the time of IC disease diagnosis was 90 (range 70-100). CNS was the only site of metastases in 17 patients (32.6%). Thirty-six lesions (66.6%) were surgically resected and GK-SRS was given as an adjuvant treatment. A median of 2 lesions were treated with GK-SRS (range 1-13). Six patients were treated with whole/partial brain radiation prior to receiving GK-SRS. Eleven patients underwent second course of GK-SRS for new/recurrent lesions at a median of 7 months from the first GK-SRS (range 2-25) and three of the patients underwent third course of GK-SRS.At the last MRI, 20 (37%) patients had new or progressive intracranial disease. Eleven patients (21.2%) subsequently received salvage whole brain radiation therapy to a median dose of 30 Gy (range 18-35) and the median time from GK-SRS to salvage WBRT was 4.6 months (range 1.6 – 14.9).The median follow up time from the diagnosis of IC disease was 28.3 months (range 4 to 195). Twenty-eight patients (53.8%) had no further CNS progression on their last brain MRI. Local recurrence rate at 6 months was 26.2% (95% CI, 18-38%) and 37.3% (95%CI, 26-51%) at 12 months. Median survival was 8.6 months from the time of IC disease diagnosis. In log-rank analysis, diagnosis of more than two lesions was the only significant factor for survival after IC disease diagnosis. The overall survival at 1 year was 86.6% (95% CI, 74-93%) and 19.9% (95% CI, 10.3-31.8%) at 5 years. Conclusion: GK-SRS is an effective treatment modality for the treatment of CNS metastases from GI primary. More than 2 brain metastasis at the time of initial diagnosis was found to be a significant factor to influence survival. The majority of patients were able to avoid WBRT, and long-term survivors were seen.

MSRO23-04 Limitations of MR Perfusion for Predicting Tumor Progression after Radiosurgery for Brain Metastases

Monday, Nov. 27 2:00PM - 2:10PM Room: S103AB

Participants
Karna Sura, MD, Royal Oak, MI (*Presenter*) Nothing to Disclose
Elena Olariu, PHD, Royal Oak, MI (*Abstract Co-Author*) Nothing to Disclose
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Prakash Chinnaiyan, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose

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ABSTRACT

Purpose/Objective(s): To correlate pre-operative magnetic resonance (MR) perfusion with post-operative pathology for primary and metastatic brain tumors.Materials/Methods: 135 patients with a diagnosis of a malignant brain tumor underwent at least one MR perfusion study using dynamic susceptibility contrast technique between January 2013 and October 2016. MR perfusion was requested at physician discretion when conventional MR imaging demonstrated either persistent or progressive enhancement at the site of treatment. 32 patients underwent subsequent surgical resection with pathological confirmation and are subjects of this analysis. 10 brain metastases (31%) and 7 glioblastoma (22%) were the majority of the patient population. 1/10 brain metastasis patient had MR perfusion which was non-analyzable and was excluded. Correlation was made between the pre-operative MR perfusion study and the final surgical pathology. Each MR perfusion scan was independently reviewed by two radiologists. Incongruent findings between the pre-operative MR perfusion diagnosis and post-operative pathology were considered discordant.Results: The median time between MR perfusion to surgery was 24 days (range: 1-502). 3/32 patients had discordant pathology with all of the discordant pathology associated with treated brain metastases. 3/9 (33%) patients with brain metastases had discordant pathology with the MR perfusion (Table 1). For brain metastases, MR perfusion had a sensitivity of 57%, specificity of 100%, positive predictive value of 100%, and negative predictive value of 40%. All of the discordant pathology had prior treatment with stereotactic radiosurgery. For GBM cases, the MR perfusion and surgical pathology had 100% concordance; however, the sample is limited in that all patients analyzed had a tumor with no cases of necrosis alone.Conclusion: MR perfusion following radiosurgery with brain metastases may have limited utility for predicting tumor progression versus radiation necrosis demonstrated by the 33% discordance rate based on pathology in this analysis. Prospective studies are necessary to determine the utility of MR perfusion for all CNS lesions, especially previously treated brain metastasis. Pathology TumorRadiation NecrosisMRI perfusionTumor404Radiation Necrosis325Total729Table 1: Correlation of pathology and MRI perfusion results in brain metastases

MSRO23-05 Adjuvant Radiation Therapy in Grade II Ependymomas: A Review of the National Cancer Database

Monday, Nov. 27 2:10PM - 2:20PM Room: S103AB

Participants
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Jiayi Huang, MD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): The role of adjuvant radiation therapy (RT) in patients with World Health Organization (WHO) grade II ependymomas after surgery remains controversial. The purpose of this study was to investigate the patterns of care of adjuvant RT for WHO grade II ependymoma and its impact on overall survival (OS) using the National Cancer Data Base (NCDB). Materials/Methods: In this study we identified 919 patients in the NCDB with a diagnosis of a WHO grade II ependymoma

treated between 2004 and 2012. Patients with metastatic disease, those who died or lost to follow-up within 2 months of surgery (to account for immortal-time bias), and those who received chemotherapy were excluded from analysis. Patients were stratified by the use of radiation therapy (RT) after surgery. OS was assessed using the Kaplan-Meier method, log-rank test and Cox proportional hazard models were used to evaluate associations between variables and overall survival. A 1:1 propensity matching was used to overcome selection bias in the allocation of RT and Kaplan-Meier analysis was performed on the matched patients. Results: A total of 516 (56%) men and 403 (44%) women were included with a median age of 48 years (range 18-90) of whom 406 (44%) received RT and 513 (56%) did not. The median time to the start of RT was 2.1 months. The median follow up was 47.9 months. Surgical extent was available in 314 (34%) patients out of which 167 (53%) had gross total resection, 79 (25%) had subtotal resection, and 68 (22%) had biopsy alone. There were no significant differences in age, sex, race, date of diagnosis, tumor location, and extent of resection between the RT vs observation groups. Median Charlson-Deyo comorbidity index (CDCI) was higher for RT. On multivariate analysis, older age at diagnosis (HR 1.04, 95% 1.03-1.05), male gender (HR 2.00, 95% CI 1.30-2.50), and CDCI= 1 (HR 1.61, CI 1.09-2.40, p=0.02) were associated with poor OS. The 5 year OS was 93% in the RT group and 92% in the observation group (p= 0.13). Further stratifying the patients by tumor location revealed that for infratentorial tumors, 5 year OS was 85% in the RT group versus 87% in the observation group (p=0.61); for supratentorial tumors, 5 year OS was 92% in the RT group versus 89% in the observation group (p=0.13). For the matched patients 5 year OS was 86% and 84% months in the RT and observation groups, respectively (p=0.29). Conclusion: WHO grade II ependymoma appears to have relatively good OS in contemporary clinical practice, and over half of them do not receive adjuvant RT. After a median follow-up of less than 5 years, adjuvant RT is not associated with significantly improved OS. Clinical benefit and strategies to optimize patient selection for adjuvant RT deserve further investigation.

MSRO23-06 Factors Associated With the Occurrence of Radiation Necrosis in Patients with Melanoma Brain Metastases Treated With Radiosurgery and Immunotherapy

Monday, Nov. 27 2:20PM - 2:30PM Room: S103AB

Participants
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ABSTRACT

Purpose/Objective(s): Radiation necrosis (RN) is a late, inflammatory reaction seen after stereotactic radiosurgery (SRS) to brain metastases (BM) typically occurring 9-18 months after SRS. At 1-year, incidence of RN in melanoma BM (MBM) treated with SRS is estimated at 6-16%[1] for a V12[2] of 3.3-5.9cm3. It is unclear how the addition of concurrent immunotherapy (IT) modifies the risk or presentation of RN for patients treated for BM. Here we examine the parameters associated with RN after SRS in patients treated with ipilumumab IT.Materials/Methods: We retrospectively reviewed twenty-five patients with 58 BM who underwent SRS and ipilimumab IT. Charts and MRIs were assessed for radiographic or pathologic (n=5) evidence of RN. Treatment consisted of SRS with a median dose of 21Gy (range 16-24Gy) and 4 cycles of IT. The V12, conformity index, GTV (cc) and PTV (cc) volumes, timing of SRS with IT, and addition of whole brain radiotherapy (WBRT) were factors analyzed in relation to overall survival (OS) and associations to RN. The diagnosis of RN was based on multiparametric MRIs and DCE perfusion imaging. Statistical analysis was performed using Kaplan-Meier with log-rank (Mantle-Cox) regression. Results: With a median follow up of 22.7 months, the median OS of this group of patients was 35.8 months. The incidence of RN was 21% (12/58) although only 5% were symptomatic. RN occurred at a median of 14.6 months after SRS (2.6-65.1months) but 25% of RN events occurred late, >24 months after SRS. The 1-, 2-, and 3-year rates of RN were 5.2%, 15.5% and 17.2% respectively. The only significant dosimetric parameter associated with RN was a V12 of 4.41 cc (1.18-10.35) versus 2.18 cc (0.45-18.6) for those with and without RN respectively (p=0.02). Seven patients had salvage WBRT at a median of 4 months after SRS, and this intervention was associated with a higher risk of RN (p=0.012). Finally, the risk of RN appears to be significantly higher when SRS was delivered before (p=0.005) or concurrently with IT (p=0.018) but not after IT (p=0.133). Patients without RN had a median OS of 22.6 months while those with RN had a median OS of 43 months (p=0.034). Conclusion: Overall, in this small cohort of patients treated with SRS and IT, RN does not appear to be occurring at a higher rate than historical series. However, we note that when SRS is delivered before or concurrently with ipilimumab, there appears to be a significantly higher incidence of RN although only a few patients become symptomatic. Surprisingly, patients developing RN appear to survive longer. V12 remains a good surrogate measure of the risk of RN. [1] Sneed, PK, Mendez J, Fogh SE et al. Risk factors for radiation necrosis after radiosurgery for brain metastases. Int J Rad Onc Biol PHys 84:S118-9, 2012. [2] Minniti G, Clarke E, Lanzetta G et al. Stereotactic radiosurgery for brain metastases: analysis of outcome and risk of brain radionecrosis. Radiat Oncol 6:48,2011.

MSRO27

BOOST: Gynecologic-Science Session with Keynote

Monday, Nov. 27 1:30PM - 2:30PM Room: S103CD

GU OB OI RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Jianling Yuan, MD, PhD, Minneapolis, MN (*Moderator*) Nothing to Disclose
Tracy M. Sherertz, MD, San Francisco, CA (*Moderator*) Nothing to Disclose

Sub-Events

MSRO27-01 Invited Speaker:

Monday, Nov. 27 1:30PM - 1:40PM Room: S103CD

Participants
Tracy M. Sherertz, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

MSRO27-02 Volumetric versus Point Based Brachytherapy Prescription in Cervical Cancer Patients Treated at a Safety Net Hospital

Monday, Nov. 27 1:40PM - 1:50PM Room: S103CD

Participants
Anthony H. Pham, MD , Los Angeles, CA (*Presenter*) Nothing to Disclose
Audrey Zhuang, PhD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
Jason C. Ye, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
Koji Matsuo, MD,PhD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
Michael A. Senikowich JR, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
Richard L. Jennelle, MD, Jackson, MS (*Abstract Co-Author*) Nothing to Disclose
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ABSTRACT

Purpose/Objective(s): Historically, brachytherapy (BT) for cervical cancer is prescribed to Point A without reference to individual tumor extent. 3D treatment planning systems have allowed for more accurate definition of the high risk clinical target volume (HR-CTV) on CT or MRI acquired after BT applicator placement. We sought to determine the impact of prescribing to Point A versus HR-CTV in our patient population at a safety net hospital treating an underserved patient population.Materials/Methods: Treatment data for 60 BT plans in 23 consecutive patients treated at a single high-volume safety net hospital from November 2014 to October 2016 was reviewed. All patients were implanted with a CT-compatible tandem and ovoid. After applicator placement, a 2.5-mm slice thickness CT scan was obtained. Point A was marked on the corresponding CT images per ABS guidelines. Organs at risk (OARs) including bladder, rectum, sigmoid, and small bowel were contoured. Dose was optimized within the treatment planning system to provide the prescription to Point A while minimizing dose to the OARs.For our study, a single physician retrospectively contoured a HR-CTV as per GEC/ESTRO consensus guidelines. A second physician confirmed these volumes. The dose volume histograms of HR-CTV and OARs were created for each application. We calculated the dose received by at least 90% of the HR-CTV (D90%) and the volume of the HR-CTV treated to the prescription dose or greater (V100%). The total volume of tissue receiving 100% of the dose was calculated for all patients. The student's t-test was used to compare groups while a linear regression was used to assess correlation between continuous variables. PResults: Overall there were 12 patients with stage IB2, 7 patients with stage IIB and 4 patients with stage IIIB disease. On exam prior to first BT implant, 9 patients had parametrial extension with 3 of those extending to the pelvic sidewall. Median brachytherapy dose was 8Gy x 3 fractions. The median volume of the total tissue irradiated was 110.6 cc and median HR-CTV volume was 23.2 cc.With the dose prescribed to point A, the median HR-CTV V100% was 98.4% and the median D90% was 9.1 Gy. In 6 out of 60 insertions (10%), D90% was less than the prescription dose. The HR-CTV volume was smaller for implants where the V100% was greater than 95% (mean = 21.77 cc, n=49), compared to those that did not (mean = 28.3cc, n=11), with a P-value Conclusion: In our underserved patient population, prescribing to point A resulted in inadequate coverage of the HR-CTV, especially in larger tumors. Continued widespread implementation of CT-based treatment planning with HR-CTV may result in improved patient outcomes by allowing for assurance of proper applicator placement, improved and consistent coverage of the tumor volume, and delineation of OARs for volume-based dose calculations.

MSRO27-03 Identifying Prognostic Factors for Locally Advanced Cervical Cancer Patients Treated with Interstitial Implantation via Hybrid Intracavitary and Interstitial Brachytherapy

Monday, Nov. 27 1:50PM - 2:00PM Room: S103CD

Participants
Amanda Rivera, Bronx, NY (*Presenter*) Nothing to Disclose
Keyur Mehta, MD, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose

Nitin Ohri, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Ravindra Yaparpalvi, MS, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose
Hsiang-Chi Kuo, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Shalom Kalnicki, MD, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): For patients with locally advanced cervical cancer, a hybrid intracavitary and interstitial tandem and ovoids applicator can be used to deliver curative brachytherapy (BT) doses to large tumors after external irradiation. Here we examine clinical and radiographic predictors of treatment efficacy in a cohort of patients treated with this approach.Materials/Methods: We reviewed an institutional database of patients with locally advanced cervical cancer who were treated with external beam radiotherapy (EBRT) and hybrid intracavitary/interstitial BT from 2010-2016. Clinical factors, including disease stage and radiotherapy course duration were recorded. Primary tumor volumes were delineated on pre-treatment PET using a commercial semi-automatic gradient-based contouring algorithm, and maximum SUV (SUVmax), metabolic tumor volume (MTV), and total glycolytic activity (TGA) values were obtained. Clinical outcomes of interest included overall survival (OS), freedom from local progression (FFLP), and progression-free survival (PFS). Survival rates were calculated using the Kaplan-Meier method, and comparisons between subgroups were made using logrank testing. Cox proportional hazards modeling was utilized to assess predictors of treatment failure.Results: Forty-six patients were treated with an EBRT dose of 45-54 Gy and a BT dose of 28-30 Gy was administered over 4-5 fractions with concurrent platinum based chemotherapy. The FIGO stage distribution was IB (5), IIB (19), IIIA (1) and IIIB (21). Forty-one patients had pre-treatment PET scans available for analysis. Median SUVmax was 14.4 (IQR 10.0-19.3), median MTV was 41 cc (IQR 26-77), and median TGA was 343 cc (IQR 154-705). With a median follow-up of 16.8 months for surviving patients, 8 local failures, 16 distant failures, and 9 deaths were observed. Among all patients, high MTV was correlated with a prolonged RT course (p=0.025). Prolonged treatment duration was associated with inferior overall survival (HR=1.04 per day, 95% CI 1.01-1.07, p=0.020). Among patients whose RT courses were completed within 10 weeks, two-year rates of OS, FFLP, and PFS were 92%, 85%, and 63%, respectively. In this subgroup, clinical stage and imaging metrics were not statistically significantly associated with any clinical outcome.Conclusion: In this review, we found that prolonged treatment course was associated with inferior clinical outcomes in patients treated with multimodality therapy including hybrid intracavitary and interstitial BT. Among patients with acceptable course duration, excellent outcomes were achieved regardless of cervical tumor disease burden indicated by PET metrics. A novel association was found between disease burden and treatment duration which warrants further study.

MSRO27-04 Patterns of Care in High Risk Early Stage (FIGO Stage IB Grade 3) Endometrioid Adenocarcinoma: A SEER Database Analysis

Monday, Nov. 27 2:00PM - 2:10PM Room: S103CD

Participants
Dane R. Cohen, MD, San Antonio, TX (*Abstract Co-Author*) Nothing to Disclose
Jennifer C. Lee, MD, San Antonio, TX (*Presenter*) Nothing to Disclose
Tony Y. Eng, MD, San Antonio, TX (*Abstract Co-Author*) Nothing to Disclose
Calvin B. Rock, BS, San Antonio, TX (*Abstract Co-Author*) Nothing to Disclose

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ABSTRACT

Purpose/Objective(s): Over the past two decades we have seen a shift in the management of endometrial cancer, with a general trend towards de-escalation of radiation in those with early stage disease and more systemic therapy in those with locally advanced tumors and higher risk histologies. Patients with high risk early stage endometrioid adenocarcinoma, specifically FIGO Stage IB Grade 3 (IBG3) tumors, are at a high enough risk of regional recurrence to warrant pelvic radiation but may not derive as much benefit from systemic treatments. We have noted a growing trend towards the use of chemotherapy in these patients. The purpose of this study is to identify trends in the use of external beam radiation therapy (EBRT), vaginal brachytherapy (VBT), and chemotherapy for adjuvant treatment of FIGO Stage IB Grade 3 (IBG3) endometrioid adenocarcinoma in the United States.Materials/Methods: Using the Surveillance, Epidemiology, and End Results (SEER) database, we identified 1383 patients with IBG3 endometrioid adenocarcinoma of the uterine corpus treated between 2004 and 2013. Patients were grouped based on the radiation treatment they received. Patients received either no radiation, EBRT alone, VBT alone, both, or other (Results: For patients with Stage IBG3 endometrioid adenocarcinoma who have undergone definitive surgery, there has been a steady increase in the use of VBT alone from 9.2% of patients in 2004 to 36.4% in 2013 (an increase of 27.2%). Over this same period of time there has been a decrease in the use of either EBRT alone (32.8% to 14.4%; a decrease of 18.4%) or in combination with VBT (18.3% to 14.4%; a decrease of 3.9%). Overall, there has been a decline in any use of EBRT (51.2% to 28.8%; a decrease of 22.4%). When stratifying patients by age > 70 or age > 50 this trend persists (25.1% and 27.3% increase in VBT alone, respectively). Conclusion: This population-based analysis reveals a marked decline in the use of EBRT in patients with IBG3 endometrioid adenocarcinoma. While the SEER database does not include chemotherapy data, we hypothesize that this decline is due at least in part to the increasing use of chemotherapy. To date there have been no randomized trials showing a clear benefit to chemotherapy over EBRT in these patients. Furthermore, recent clinical trials have grouped these tumors with either higher stage disease or higher risk histologies when in fact the natural history may be very different. Our findings highlight a concerning trend towards undertreatment of regional disease in a population of patients with a high enough risk to warrant pelvic radiation. Additional work is currently under way to test this hypothesis with the National Cancer Database (NCDB) which captures chemotherapy data.

MSRO27-05 Multi-institution Health Care Review of Uterine Papillary Serous Carcinoma

Monday, Nov. 27 2:10PM - 2:20PM Room: S103CD

Participants
Janna Z. Andrews, MD, Lake Success, NY (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Uterine papillary serous carcinoma (UPSC) represents less the 15% of endometrial cancers and is recognized as an aggressive tumor with poor prognosis. 50% of patient with Stage I UPSC will have extrauterine disease. UPSC contribute to roughly 50% of endometrial cancer related mortality. While surgery is the cornerstone of treatment for UPSC, the optimal adjuvant treatments of USPC remains controversial given the lack of randomized trials. This retrospective study presents the patterns of

failure based on various treatment approaches from a multi-institutional database.Materials/Methods: Tumor registry data from 2010-2015 identified 119 patients (pts) with UPSC treated at three different institutions within the health care system. Treatment was highly variable with 52 (46%) patients treated with surgery, chemotherapy, and radiation, 21 (17%) treated with surgery alone, 20 (17%) treated with chemotherapy and surgery, 8 (6%) treated with surgery and radiation, 8 (6%) received no treatment, 7 (6%) treated with chemotherapy alone, 3 (2%) treated with radiation alone, and 2 (1%) received only chemotherapy and radiation. There was treatment heterogeneity was across all stages of disease. Survival was analyzed by Kaplan Meier.Results: With a median follow up of 18 months, 88 pts (74%) were alive with 70 (58%) disease free with an overall. Disease free recurrence rates for patients were 13 (62%) treated with surgery alone, 10 (55%) in patients treated with chemotherapy and surgery, 6(75%) in patients treated with radiation and surgery, and 42(80)% of patients treated with trimodality therapy. Stage IA had the highest local control and overall survival rates at 18 months, 82% and 87%, the majority of the patients received trimodality therapy. Stage III patients had a local control rate was 42% and 54% overall survival rates at 18 months. Trimodality therapy was given to the majority of these patients, 16(51%). 11(68%) were alive at 18 months. NED status was achieved by 80% of the chemotherapy and surgery arm and the trimodality arm. Overall survival was higher in the trimodality arm, 73% compared to 60% in the surgery chemotherapy arm.Conclusion: This large retrospective multi-institutional review of UPSC demonstrates a significant amount of heterogeneity in the treatment for UPSC. Given the lack of level I data for UPSC, it is not surprising that treatments are highly variable. The literature cites a 5 year overall survival rate of 59% for Stage III patients with trimodality treatment. Our initial review of overall survival is comparable but longer follow up is necessary. Potentially institutional variability may also play a role in poor outcomes. While no optimal treatment approach is identified from this data, we will present a treatment algorithm that can be used when assessing pts with UPSC and which can be used to inform future clinical trials.

MSRO27-06 Gynecologic Sarcomas: A Ten Year Demographics, Disease, Treatment and Outcome Analysis from a Large Tertiary Level Teaching Hospital

Monday, Nov. 27 2:20PM - 2:30PM Room: S103CD

Participants
Gaurav Bhattacharya, Ottawa, ON (*Presenter*) Nothing to Disclose
Matthew` Tsang, MSc, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose
Samy El-Sayed, MD, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose
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ABSTRACT

Purpose/Objective(s): Gynecologic sarcomas, a group of rare tumors of the female reproductive tract, carry a relatively poor prognosis. This study identifies patient, disease and treatment characteristics across a prolonged time period and ascertains clinical outcomes at our major cancer referral center.Materials/Methods: Patients with gynecologic sarcomas in a ten year span from January 1, 2005 to January 1, 2015 were tabulated from a larger pool of 968 soft tissue tumors, with follow up data to ensure at least two years of post-treatment data collection. This was done via analysis of Electronic Medical Records, paper charts and contact with peripheral medical centers and family practitioners' offices, especially for patients lost to follow up at the center. The inclusion criterion was age = 18 years and histological diagnosis from the intermediate and malignant sections of the 2002 World Health Classification of tumors. Carcinosarcomas (formerly known as Malignant Mixed Mullerian Tumors) and collision tumors (defined as two histologic tumor types originating in the same anatomic site) were also included in this analysis. The exclusion criterion was inadequate histological diagnosis. A literature review was also conducted to identify current outcomes trends. Overall survival was analyzed using Kaplan-Meier methodology.Results: One hundred and twelve patients meeting selection criteria were identified. Mean age at diagnosis was 65 years (Standard Deviation/SD: 12) with a median follow up of 30 months. The most common presenting symptoms were vaginal bleeding (50%) and mass ± pain (12%). Only 4 of the patients had no apparent clinical symptoms. Disease site was overwhelmingly of the uterine corpus (86%). The most common histologies were Carcinosarcoma (56%) and Leiomyosarcoma (37%). Mean tumor size was 10 cm (SD: 7) with a mean pre-treatment Hemoglobin value of 11.7 g/dl (SD: 2.1).A majority (88%) received treatment with curative intent. Radiation (49% of all patients) and chemotherapy were provided largely in an adjuvant setting. The most common fractionation regimen was 45 Gy in 25 fractions. From a surgical perspective, most patients were treated with a total abdominal hysterectomy with bilateral salpingoophorectomy. Bilateral lymphadenectomy was conducted in 31% of such surgeries and at least 18% had positive margins.Stage distribution by incidence was: Stage I 40%, Stage II 12%, Stage III 21% and Stage IV 24%. Forty percent of patients had a recurrence with 62% of patients still alive at time of latest follow up. Thirteen patients had a component of local disease progression or recurrence. Overall survival estimates at three and five years were 81% and 45% respectively. Conclusion: The creation of a gynecologic sarcoma database grants an array of details to establish a foundation for further assessment of clinical outcomes. Further research is required on the potential for both locoregional and systemic control improvement with likely benefit from studying outcomes stratified by histology.

SSE01

Breast Imaging (Ultrasound Screening)

Monday, Nov. 27 3:00PM - 4:00PM Room: Arie Crown Theater

BR US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Wendie A. Berg, MD, PhD, Pittsburgh, PA (*Moderator*) Nothing to Disclose
Stamatia V. Destounis, MD, Scottsville, NY (*Moderator*) Hologic, Inc. Scientific Advisory Board

Sub-Events

SSE01-01 Ultrasound Screening After Digital Mammography versus Digital Breast Tomosynthesis

Monday, Nov. 27 3:00PM - 3:10PM Room: Arie Crown Theater

Participants
Elizabeth H. Dibble, MD, Providence, RI (*Presenter*) Nothing to Disclose
Tisha M. Singer, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Nneka Jimoh, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Grayson L. Baird, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Ana P. Lourenco, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To compare the yield of dense breast ultrasound (US) screening following digital mammography (DM) versus digital breast tomosynthesis (DBT).

METHOD AND MATERIALS

IRB-approved, HIPAA compliant retrospective search of radiology databases at two tertiary breast imaging centers and an office practice staffed by the same fellowship-trained breast radiologists to identify screening US examinations from 10/1/14-9/30/16. Prior DM vs. DBT, demographic information, abnormalities on screening US, and pathology results were recorded. Additional breast cancers detected with US after DM vs. DBT and additional benign lesions requiring biopsy or follow-up were calculated. Because the time between DM or DBT and US varied, time between exams was estimated using Kaplan-Meier analysis. Differences between DM and DBT were compared using Chi Square and Fisher's Exact Tests.

RESULTS

3187 screening breast US exams were performed (3025 (94.9%) initial screening US exam; mean age 54.4, range 18.2-90.1); 1434 after DM and 1672 after DBT. 81 did not have a prior mammogram available. There were 201(14.0%) BI-RADS 3 results after DM and 177 (10.6%) after DBT (p=0.004). 119 biopsies or aspirations had results available. Of the 44 biopsies or aspirations after DM, 7 (16%) were malignant and 37 (84%) were benign; of the 75 biopsies or aspirations after DBT, 9 (12%) were malignant and 66 (88%) were benign (p=0.546). The additional cancer detection rate by US after DM was 5/1434 or 3.5 per 1000 women screened and after DBT was 5/1672 or 3 per 1000 women screened (p=0.810). Figure 1 summarizes US screening results. The median time between cancer detection with US after DM vs. DBT was not statistically significantly different (p=0.999).

CONCLUSION

No significant difference was observed in additional cancer detection rate with screening US following DM vs. DBT. The BI-RADS 3 rate of screening US was significantly lower following DBT.

CLINICAL RELEVANCE/APPLICATION

Knowing that the cancer yield of screening US is similar for prior DBT vs. DM may help inform clinical practice, as questions abound about whether DBT is sufficient supplemental screening for women with dense breast tissue.

SSE01-02 A Prospective Study of Automated Breast Ultrasound (ABUS) in a DBT Based Screening Practice of Women with Dense Breasts

Monday, Nov. 27 3:10PM - 3:20PM Room: Arie Crown Theater

Participants
Denise M. Chough, MD, Pittsburgh, PA (*Presenter*) Nothing to Disclose
David Gur, PhD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Grace Y. Rathfon, MD, Monroeville, PA (*Abstract Co-Author*) Nothing to Disclose
Amy H. Lu, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Terri-Ann Gizienski, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Christiane M. Hakim, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
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Wendie A. Berg, MD, PhD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess prospectively the informativeness and reporting consistency of ABUS as supplemental imaging of women with dense breast tissue as determined from prior mammograms.

METHOD AND MATERIALS

We are currently performing a prospective, fully balanced, IRB approved trial in which women with dense breasts undergo DBT plus ABUS screening. Two of six specifically trained, participating radiologists independently and sequentially first interpret DBT, or ABUS, alone and then interpret the other modality. The primary interpreting radiologist receives the second interpreting radiologist's opinion only when there is a disagreement and determines the final clinical management recommendation. We report all screening recommendations and diagnostic outcomes on the first 467 examinations performed prior to January 31, 2017 and for which all diagnostic workups, if any, are complete.

RESULTS

Of 934 initial independent interpretations (467X2), the initial recall recommendations rates were 64 (6.9%) and 102 (10.9%) on DBT alone and ABUS alone, respectively. Disagreement rates between the two readers for the same modality (double readings) were higher ($p < 0.05$) for ABUS (68 disagreements) than DBT (48 disagreement). After reviewing second opinions, when applicable, by the primary reader, 29 initial recommendations/decisions were changed (11 from "negative" or "benign" to "recall" and 18 from "recall" to "negative" or "benign). Only 31% of actually recalled patients were initially recalled by both modalities, suggesting that DBT and ABUS tend to frequently depict different "suspicious" abnormalities. Of the 15 biopsies performed to date, 3 were initially recalled by DBT alone, 7 by ABUS alone, and 5 by both. Three cancers were found, two initially recalled by both DBT and ABUS and one was recalled by ABUS only.

CONCLUSION

ABUS, perhaps with double reading only of examinations initially rated as BIRDS 0, may prove efficacious as a supplement to DBT and possibly as a primary screening modality of women with dense breasts.

CLINICAL RELEVANCE/APPLICATION

ABUS with double readings of initially suspected examinations should be investigated both as a potential supplement to DBT as well as a possible primary screening modality of women with dense breasts.

SSE01-03 Accuracy and Outcomes of Screening Breast Ultrasound in Women with a Personal History of Early-Stage Breast Cancer

Monday, Nov. 27 3:20PM - 3:30PM Room: Arie Crown Theater

Participants
Soo-Yeon Kim, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
Nariya Cho, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Bo Ra Kwon, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Sung Ui Shin, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Sooyeon Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Su Hyun Lee, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Jung Min Chang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Research Grant, General Electric Company
Woo Kyung Moon, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the performances of breast ultrasonographic (US) screening in women with a personal history of breast cancer (PHBC) by comparison with those in women without personal history of breast cancer (non-PHBC).

METHOD AND MATERIALS

Between January 2013 and December 2013, 12747 consecutive screening whole breast US examinations were identified. Among them, women with early-stage breast cancer (stage 0, I or II) were eligible. Non-PHBC women who underwent incident screens at least 9 months ago and had negative mammography and at least 1-year follow-up were matched 1:1 to PHBC women according to breast density and age. Screening performance measures were calculated and compared between the two groups by using generalized estimation equation or chi-square test. Characteristics of screen-detected and interval cancers were described.

RESULTS

There were 3435 exams in 3226 PHBC women (mean age, 52.3; range, 24-83 years) and 3291 exams in 3226 matched women without PHBC (mean age, 52.2; range, 25-84 years) (603 fatty, 2623 dense women for each group). Fourteen cancers (10 screen-detected, 4 interval cancers) were observed in PHBC women and 13 cancers (12 screen-detected, 1 interval cancer) in non-PHBC women. Performances of PHBC vs non-PHBC women were similar in the following outcomes; cancer detection rate of 2.9 per 1000 vs 3.6 per 1000 (P=.60), interval cancer rate of 1.2 per 1000 vs 0.3 per 1000 (P=.23), sensitivity of 71.4% (10/14) vs 92.3% (12/13) (P=.33), positive predictive value for biopsy performed(PPV3) of 10.9% (4/37) vs 21.1% (12/57) (P=.20). Specificity and abnormal interpretation rate of PHBC were better than those of non-PHBC as follows; 93.2% (3176/3421) vs 89.6% (2917/3278) (P<.001) and 7.4% (255/3435) vs 11.2% (373/3291) (P<.001). In addition, 70% (7/10) of screen-detected cancers and 50% (2/4) of interval cancers in PHBC women were stage I or II, while all observed cancers (100%, 13/13) were stage I or II in non-PHBC women (64.3% [9/14] vs. 100% [13/13], P=.04).

CONCLUSION

US screening in PHBC women detects early second breast cancers with higher specificity, however, has more advanced stage observed cancers, relative to those in non-PHBC women.

CLINICAL RELEVANCE/APPLICATION

Supplemental breast US screening in addition to mammography is recommendable for breast cancer survivors, although more advanced stage cancers are observed than those in non-PHBC women.

SSE01-04 Background Echotexture on Breast Ultrasound: Impact on Diagnostic Performance of Supplemental Screening in Women with Negative Mammography

Monday, Nov. 27 3:30PM - 3:40PM Room: Arie Crown Theater

Participants
Su Hyun Lee, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Ann Yi, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Jung Min Chang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Research Grant, General Electric Company
Nariya Cho, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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Soo-Yeon Kim, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

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PURPOSE

To evaluate the effect of background echotexture on the diagnostic performance of screening ultrasound (US) in women with negative mammography.

METHOD AND MATERIALS

This retrospective study was approved by our institutional review board and the requirement for written informed consent was waived. Between January 2012 and December 2014, 10277 women who underwent screening US after negative mammography and had a report on background echotexture were identified. Bilateral whole breast US were performed with a handheld device by experienced radiologists. Background echotexture was prospectively assessed according to the BI-RADS classification. The abnormal interpretation rate, cancer detection rate, and positive predictive value of screening US were compared between groups with homogeneous and heterogeneous background echotextures using a chi-square test.

RESULTS

Of 10277 women, 7206 (mean age, 53.6 yrs) showed homogeneous background echotexture and 3071 (mean age, 48.5 yrs; P<.001) showed heterogeneous background echotexture. Abnormal interpretation rate was significantly higher in group with heterogeneous background echotexture than those with homogeneous background echotexture (20.0% [613/3071] vs 8.1% [582/7206]; P<.001). Eleven cancers (4 DCIS and 7 invasive) were detected in group with homogeneous background echotexture (cancer detection rate, 1.5 per 1000 exams) and 9 cancers (1 DCIS and 8 invasive) were detected in group with heterogeneous background echotexture (cancer detection rate, 2.9 per 1000 exams; P=.147). Positive predictive value for biopsy performed (PPV3) was 9.5% (10/105) in group with homogeneous background echotexture and 5.0% (5/100) in group with heterogeneous background echotexture (P=.286). There were 3 known false-negative screening US in our study population, all performed in women with heterogeneous background echotexture.

CONCLUSION

Heterogeneous background echotexture on breast US was associated with higher abnormal interpretation rate in supplemental screening. Higher cancer detection rate and lower PPV3 were noted in screening US with heterogeneous background echotexture although the difference was not statistically significant.

CLINICAL RELEVANCE/APPLICATION

Background echotexture can affect the diagnostic performance of screening US. Care should be taken when interpreting screening US in women with heterogeneous background echotexture.

SSE01-05 Diagnostic Performance of Automated Breast Ultrasound in Breast Cancer Screening: Independent Evaluation of Coronal View and Transverse View

Monday, Nov. 27 3:40PM - 3:50PM Room: Arie Crown Theater

Participants
Megumi Nakajima, MD, Obihiro-Shi, Japan (*Presenter*) Nothing to Disclose
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PURPOSE

Automated Breast Ultrasound (ABUS) has been proven to find more invasive breast cancers when used as adjunct to mammography (MG) in screening. ABUS is characterized by coronal view (CV) and transverse view (TV). ABUS reading is directed to go through both views to elicit the result. Despite CV is innovative and potential invention of diagnostic ultrasound, no independent scientific evaluation has ever been pursued. Purpose of this study is to pursue diagnostic performance and efficiency of CV and TV independently. The way of reading whole breast data of ABUS is different from hand-held ultrasound (HHUS), and we have investigated the efficient way. The CV is unique view of ABUS which we are not used to reading and the TV is similar to HHUS which we are used to. We think detecting by CV and evaluating by TV is safe and short time way in breast cancer screening. So we studied about the safety of detecting breast cancers by CV by comparing with TV. This prospective study is the first trial to evaluate the diagnostic performance of ABUS in comparison between CVand TV.

METHOD AND MATERIALS

Two separate image data sets (a total of 200 breasts, 100 CVs & 100 TVs) were blindly prepared. Each set contained unilateral breast images 32 nomal, 38 benign, and 30 malignant cases. All readers completed ABUS Mandatory Program in advance.Three breast cancer specialists (A,B,C) of different degrees of experience with ABUS (A: >2y ABUS, B: 50 ABUS, C: HHUS only) read CV

and TV independently. Two sets were read separately, whithin one hour per day, with no clinical imformation. Subjects: ABUS (Oct.2014 - Jan.2017). 24-81 y.o.(median: 552.0, average: 53.2). A total of 30 cancers were DCIS (4), IDC (22), mucinous carcinoma (2), ILC (2), and findings of them were non-mass (4) and masses (26). Average tumor size was 13.8mm (6.1mm-23.2mm). BI-RADS (ACR) categories were used for evaluation.The sensitivity, specificity and reading time were assessed.

RESULTS

1. Sensitivity was 80.0% and 75.6% (CV vs TV, *P*=0.0179). 2. Specificity was 81.9% and 80.5% (CV vs TV, *P*=0.423). 3. The average reading time of CV and TV were 136 seconds/case and 166 seconds/case respectively.

CONCLUSION

Diagnostic performance of CV was superior to TV, and reading time was shorter in CV. CV was suggested to be useful in screening setting.

CLINICAL RELEVANCE/APPLICATION

Future appropriate application of CV interpretention has a potential to improve values of ABUS in breast cancer screening.

SSE01-06 Recall Rates for Technologist-Performed Screening Ultrasound Compared to DBTs and Influence of Double Reading

Monday, Nov. 27 3:50PM - 4:00PM Room: Arie Crown Theater

Participants
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PURPOSE

To assess recall rate after technologist-performed handheld screening ultrasound (US) read in batch mode compared to recall rate using tomosynthesis with synthetic 2D reconstructions (DBTs) in women with dense breasts.

METHOD AND MATERIALS

Across three practices, from 12/1/15 through 1/31/17, 3021 women, with at least heterogeneously dense breasts by prior mammography or on baseline, aged 40-75 years, were enrolled in an IRB-approved HIPAA-compliant protocol to have technologist-performed handheld US with standard documentation after clinically performed DBTs. Two breast-imaging specialist radiologists reviewed images from each modality in batch mode, initially blinded to the other modality results, with one observer interpreting US first and one DBTs first. After reviewing both modalities together, observers were asked if they would still recall the patient. Reader 1 considered the input of reader 2 for final participant management.

RESULTS

Median participant age was 54.5 years. Across 6042 readings (3021x2), recall rate from either observer on DBTs was 496 (8.2%) and from US 576 (9.5%, p= 0.009); after reviewing both modalities, recall was recommended in 821 (13.6%) of interpretations. This represents an increase in recalls of 325/6042 (5.4%) compared to DBTs alone. Recall rates varied significantly by site, ranging from 2.5% to 14.5% (p<0.0001) for ultrasound and from 3.2% to 10.4% (p<0.0001) for DBTs. Only 42 US recalls were for immediate additional evaluation (BI-RADS 0) before a final assessment could be rendered. There were 376 reader disagreements regarding participant recall: 172 based on US only; 210 on DBTs only; and 25 on both. After reader integration, 18 participants were changed to US recall, 32 to DBTs recall, and 9 to both; 2 were changed to no recall on US, 19 to no recall on DBTs, and 32 to no recall on either modality, for a net change of 6 additional recalls.

CONCLUSION

Adding technologist-performed handheld US to screening DBTs increased recall rate by 5.4%. Observers gave a final assessment for 6000/6042 (99.3%) interpretations of technologist-performed handheld US using a standardized screening protocol. Double reading had a neutral effect on recall rate.

CLINICAL RELEVANCE/APPLICATION

It is feasible to implement technologist-performed screening US with batch interpretation, though recall rates for additional testing varied by site.

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McCormick Place, Chicago
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SSE02

Breast Imaging (MRI Response to Neoadjuvant Treatment)

Monday, Nov. 27 3:00PM - 4:00PM Room: E450A

BR MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Elizabeth A. Morris, MD, New York, NY (*Moderator*) Nothing to Disclose
Constance D. Lehman, MD, PhD, Boston, MA (*Moderator*) Research Grant, General Electric Company; Medical Advisory Board, General Electric Company

Sub-Events

SSE02-01 Phenotypic Biomarkers of Intra-Tumor Heterogeneity in Breast DCE-MRI Can Augment Tumor Volume Measures in Predicting Survival after Neoadjuvant Chemotherapy for Locally Advanced Breast Cancer: Results from the ACRIN 6657/I-SPY-1 Trial

Monday, Nov. 27 3:00PM - 3:10PM Room: E450A

Participants
Despina Kontos, PhD, Philadelphia, PA (*Presenter*) Nothing to Disclose
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PURPOSE

Breast cancer is biologically heterogeneous. Image-based assessment may alleviate pathologic sampling limitations to allow for more comprehensive assessment of tumor heterogeneity. We investigate tumor heterogeneity metrics derived from DCE-MRI as biomarkers to augment early prediction of long-term survival after neoadjuvant chemotherapy for locally advanced breast cancer.

METHOD AND MATERIALS

The ACRIN 6657/ISPY-1 trial cohort was accessed from NCI's Cancer Imaging Archive and DCE-MRI images were retrospectively analyzed for 106 women who had complete clinical and imaging data with tumor segmentations. Age, race, hormone receptor status (ER/PR/Her2), and functional tumor volume (FTV) were available. Four kinetic features (signal enhancement ratio, peak enhancement, wash-in/wash-out slope) were computed voxel-wise from DCE-MRIs acquired at the first post-treatment visit. Spatio-temporal heterogeneity was quantified for each feature using multi-resolution wavelets and principal component analysis was applied on the wavelet decomposition feature vectors to reduce dimensionality. Time-to-event analysis was performed using the Cox proportional hazards model and prediction of recurrence-free survival (33 events) was estimated with the c-statistic. A baseline model with FTV, age, race, and receptor status was compared using the likelihood-ratio test (LRT) to a model where tumor heterogeneity measures were added based on their univariate performance and low (<0.25) correlation to FTV.

RESULTS

The baseline model with age, race, receptors, and FTV had a c-statistic=0.70 (p=0.005), where FTV was the only significant predictor (p<0.001). A parsimonious model including FTV plus the top four univariate performing tumor heterogeneity features with low correlation to FTV had a c-statistic=0.77 (pLRT<0.001), where 3 out of 4 included features had independent contribution (p<=0.05). A model including the four heterogeneity features, but without FTV, had a c-statistic=0.71 (p=0.007), indicating similar performance to FTV.

CONCLUSION

Our preliminary data suggests that early prediction of survival after breast neoadjuvant chemotherapy can be improved when DCE-MRI measures of tumor heterogeneity are added to tumor volume measures.

CLINICAL RELEVANCE/APPLICATION

Tumor heterogeneity analysis via imaging may improve prediction of therapeutic efficacy, allowing for early treatment modification to avoid futile therapy while achieving precision cancer treatment.

SSE02-02 Patterns, Predictive Factors of Locoregional Recurrence in Breast Cancer Patients Undergone Breast-Conserving Surgery After Tumor Down-staging by Neoadjuvant Chemotherapy

Monday, Nov. 27 3:10PM - 3:20PM Room: E450A

Participants
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Woo Kyung Moon, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

We evaluated patterns and predictive factors of locoregional recurrence (LRR) in patients undergone BCS after tumor down-staging through NAC by comparison with those of pre-planned BCS group.

METHOD AND MATERIALS

Between October 2003 and September 2015, 688 consecutive breast cancer patients who had undergone BCS after NAC were identified. Patients with incomplete clinicopathologic information (n=27), bilateral breast cancer (n=6), or unavailable preoperative breast MRI (n=3) were excluded. Finally, 652 women (mean age, 45.4 years; range, 22-78 years) composed of 551 down-staged BCS and 101 pre-planned BCS patients were included. Rate and site of LRR were compared between the two groups using Fisher's exact test. MR imaging features (non-mass enhancement, rim enhancement, and peritumoral edema) and clinicopathologic features (age, stage, histologic grade, lymphovascular invasion, margin status, tumor subtype, radiotherapy, endocrine therapy) were analyzed to identify independent predictors associated with LRR by using multivariable regression analysis. Median follow-up was 64.1 months.

RESULTS

LRRs were diagnosed in 50 patients (9.8% [72.0% local and 28.0% regional]). No difference was found in the rate of LRR between the down-staged and pre-planned BCS groups (9.8% [54/552] vs. 9.9% [10/101], P=.975). LRR was more frequently found at the original tumor bed in down-staged BCS group than in pre-planned BCS group (50.9% [27/53] vs. 10% [1/10]; P=.016). In multivariable regression analysis, younger age <= 40 years (OR = 2.180, 95% CI = 1.157 to 4.108, P=.016), pathologic stage of 3 (OR = 6.297, 95% CI =2.614 to 15.170, P=<.001), and absence of radiotherapy (OR = 5.222, 95% CI =1.832 to 14.880, P=.002) remained an independent predictor of LRR. In addition, there was a tendency that patients with non-mass enhancement on preoperative MRI experience LRR (OR = 2.119, 95% CI = 0.976 to 4.597, P=.058).

CONCLUSION

Non-mass enhancement on preoperative MRI tends to be associated with LRR which frequently occurs in the original tumor bed in breast cancer patients undergone BCS after down-staging by NAC.

CLINICAL RELEVANCE/APPLICATION

Although BCS after tumor down-staging by NAC is oncologically safe, careful postoperative surveillance is needed for the original tumor bed, when non-mass enhancement was present on initial MRI.

SSE02-03 Comparison of Pathologic Response Evaluation Systems after Neoadjuvant Chemotherapy in Breast Cancers: Correlation with Breast MRI Computer-Aided Detection

Monday, Nov. 27 3:20PM - 3:30PM Room: E450A

Participants
Woo Jung Choi, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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Eun Young Chae, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Several pathologic methods are used to assess the tumor response of breast cancer after neoadjuvant chemotherapy (NAC) to predict clinical outcome. The purpose of the study was to investigate the tumor response after NAC using dynamic contrast-enhanced (DCE) magnetic resonance (MR) imaging parameters assessed with a commercially available computer-aided system and analyzed their correlation with pathologic response assessment systems.

METHOD AND MATERIALS

Our institutional review board approved this retrospective study. Between January and December 2015, 223 consecutive patients who had DCE MR imaging before and after completion of NAC prior to definitive surgery were included. The reduction rate of maximum diameter, volume, peak enhancement, and persistent, plateau, and washout-enhancing components were measured with a computer-aided system on DCE MR images and correlated with the Miller-Payne grading system, residual breast cancer burden (RCB) classes and RCB index.

RESULTS

The reduction rate was 65.5 ± 34.5 for maximum diameter, 84.4 ± 46.6 for volume, 56.8 ± 48.1 for peak enhancement, -31.0 ± 426.1 for persistent component, -7.8 ± 756.9 for plateau component, and 42.8 ± 225.9 for washout component. All six MR imaging parameters showed the best correlation with the Miller-Payne grading system (r = 0.472 to 0.722, P < 0.001), followed by RCB class (r = -0.580 to -0.412, P < 0.001) and RCB index (r = -0565 to -0.413, P < 0.001). Comparing with Miller-Payne grading system, the reduction rate of volume (r = 0.722, P < 0.001) showed the strongest correlation followed by maximum diameter (r = 0.687, P < 0.001), peak enhancement (r = 0.638, P < 0.001), plateau component (r = 0.562, P < 0.001), washout component (r =

0.548, P < 0.001), and persistent component (r = 0.472, P < 0.001).

CONCLUSION

Miller-Payne grading system showed the best correlation with the changes of DCE MR imaging parameters measured automatically by a commercially available computer-aided system, and the reduction rate of tumor volume measured on MR imaging showed the strongest correlation with the pathologic tumor response.

CLINICAL RELEVANCE/APPLICATION

The reduction rate of tumor volume measured on MR imaging showed the strongest correlation with the Miller-Payne grading system and could be applied to predict pathologic response.

SSE02-04 DCE-MRI Texture Features of Locally Advanced Breast Cancer: Correlation with Tumor Biomarkers, Post-Treatment Imaging and Pathologic Complete Response

Monday, Nov. 27 3:30PM - 3:40PM Room: E450A

Participants
Laura Heacock, MD, MS, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

Computer-extracted texture analysis of locally advanced breast cancers (LABC) on pre-treatment dynamic contrast MR imaging (DCE-MRI) may predict radiomic classification of tumors and pathologic response. The purpose of this study was to evaluate tumor and peritumoral texture features associated with tumor type, pathologic complete response (pCR), and post-treatment imaging volume.

METHOD AND MATERIALS

In this institutional review board-approved study, 44 women with LABC underwent breast DCE-MRI on a 3.0T magnet prior to and after neoadjuvant chemotherapy. In-house segmentation software was used to draw whole lesion 3D regions of interest on pre- and post-treatment imaging and automatically select a peritumoral enhancement ring. Computer-generated texture features for whole lesion and peritumoral enhancement were extracted from fat-suppressed first post-contrast T1-weighted (T1W) and corresponding subtraction (sub) pre-treatment images using three spatial scales (SS) at ~1 mm/4 mm/8 mm resolution. Texture features were correlated with tumor biomarkers, post-treatment imaging % volume change, and pCR, using Kruskal-Wallis, Mann-Whitney and Spearman rank tests.

RESULTS

Cancers were 29.5% (13/44) estrogen receptor/progesterone receptor positive, (ER/PR+), 15.9% (7/44) triple negative breast cancer (TBNC) and 54.5% (24/44) human epidermal growth factor receptor 2-overexpressed (HER2+). 43% (19/44) achieved pCR. For all lesions, lesion entropy on SS-8 mm sub images correlated with pCR (p=0.039). Peritumoral enhancement mean on T1W images correlated with ki-67 (R=0.391, p=0.024); peritumoral enhancement entropy (R=0.433, p=0.006) and skew (R=0.0372, p=0.02) correlated with volume change after chemotherapy. Peritumoral enhancement entropy on T1W (p=0.018) and sub images (p=0.042) correlated with tumor markers, as did whole lesion sub mean (p=0.004), skew (p=0.003), kurtosis (p= 0.003) and entropy (p=0.049). For HER2+ cancers, peritumoral and whole lesion features did not predict pathologic or imaging response, but correlated to ki-67 (R=0.662, p=0.003; R=0.604, p=0.008).

CONCLUSION

Whole lesion and peritumoral texture features on pre-treatment DCE-MRI may predict tumor biomarkers and response to neoadjuvant chemotherapy in LABC.

CLINICAL RELEVANCE/APPLICATION

Pre-treatment DCE-MRI texture features may predict tumor aggressiveness and response to neoadjuvant chemotherapy in locally advanced breast cancer, allowing for targeted treatment.

SSE02-05 Texture Entropy Features at 1 Centimeter Outside HER2+ Breast Cancer Lesions Predict Response-Associated Molecular Subtypes on DCE-MRI

Monday, Nov. 27 3:40PM - 3:50PM Room: E450A

Awards
Trainee Research Prize - Medical Student

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PURPOSE

Radiomics (computerized imaging feature extraction) has been successful in the prediction of breast cancer biology and outcomes, but has thus far focused within the lesion or bulk parenchyma. In this work, we evaluate whether radiomic features relating to heterogeneity patterns extracted from outside the tumor are predictive of the molecular sub-subtypes (enriched and non-enriched) of HER2+ breast cancers identified by PAM50 profiling. We hypothesize that the HER2-Enriched (HER2E) subtype, associated with high treatment response, may be distinguishable by radiomic analysis of the peritumoral region on DCE-MRI.

METHOD AND MATERIALS

42 1.5 or 3 T pre-treatment DCE-MRI scans of HER2+ patients with PAM50-identified molecular subtype (19 HER2E, 23 non-HER2E) were retrospectively analyzed. Radiomic features (Co-occurrence of Local Anisotropic Gradient Orientations (CoLIAGe), Laws, Haralick, and Gabor) were computed intratumorally and within 3 mm annular peritumoral rings out to a 15 mm radius . The top 5 HER2E-associated features within each region were identified by Wilcoxon feature selection and used to train a diagonal linear discriminant analysis classifier in a 3-fold cross-validation setting. The feature most commonly selected across all bins was identified and used to predict HER2E alone in each region.

RESULTS

The set of top intratumoral features, consisting of Gabor, Haralick, and Laws features, predicted HER2E with an area under the receiver operating characteristic curve (AUC) of .77 +/- .03. Within the 6-9 mm and 9-12 mm bins, top feature sets consisted solely of CoLIAGe features and predicted HER2E with AUCs of .82 +/- .03 and .83 +/- .02, respectively. Statistics of the single most commonly selected feature only (CoLIAGe Difference Average) predicted HER2E most effectively within the 9-12 mm bin (AUC = .77 +/- .02), but performed poorly intratumorally (AUC = .51 +/- .07).

CONCLUSION

Texture features extracted 6-12 mm beyond the lesion were found to distinguish HER2+ sub-subtypes more strongly than features within the tumor. Elevated disorder of intensity gradient orientations detected by CoLIAGe features in the peritumoral region better identified HER2E compared to texture features from within the tumor.

CLINICAL RELEVANCE/APPLICATION

Imaging features from the peritumoral region may help enable non-invasive sub-subtyping of breast cancer patients and provide new insights into tumor biology that are as yet poorly understood.

SSE02-06 Performance of Late Enhancement and Apparent Diffusion Coefficient Ratio Detected on Magnetic Resonance Imaging to Predict Pathologic Response after Neoadjuvant Systemic Therapy in Various Breast Cancer Subtypes

Monday, Nov. 27 3:50PM - 4:00PM Room: E450A

Participants
Gorane Santamaria, MD, PhD, Barcelona, Spain (*Presenter*) Nothing to Disclose
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PURPOSE

To assess the performance of MR late enhancement (LE) and apparent diffusion coefficient (ADC) ratio to predict pathologic response (PR) after neoadjuvant systemic therapy (NST) in breast cancer subtypes.

METHOD AND MATERIALS

This was a prospective study with waiver of informed consent. From January 2015 to December 2016, 83 women (mean age, 58) with breast cancer undergoing NST were enrolled. Eight lesions (10%) were immunohistochemically HER2+, 12(14%) triple negative, 10(12%) luminal A-like, 43(52%) luminal B-like and 10(12%) luminal B-like/HER2+. Breast MRI was performed before and after NST. On MRI, absence or presence of LE in the posttreatment exam and ADC ratio (ADC postreatment/ADC pretreatment) of the lesion were assessed. Pathologic complete response (pCR) was defined as no residual ductal carcinoma in situ or invasive disease in the breast. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and global accuracy of LE were calculated. Receiver operating characteristic (ROC) curves evaluated the predictive performance of univariate and multivariate models for PR.

RESULTS

PCR was reported in 16% (13/83) of cases. Absence of LE was observed in 19% (16/83). Overall, assessment of LE after NST had a 87% sensitivity, 54% specificity, 91% PPV, 44% NPV and 82% accuracy to predict PR. The breakdown by subtypes showed no pCR in luminal A-like or luminal B-like/HER2+. Luminal B-like subgroup achieved pCR in 9% (4/43). Triple-negative cancers showed pCR in 33% (4/12) and LE predicted PR with 100% sensitivity, 20% specificity, 73% PPV, 100% NPV and 75% accuracy. Finally, the HER2+

subgroup responded the most, achieving pCR in 63% (5/8) with LE predicting PR with 67% sensitivity, 80% specificity, 67% PPV, 80% NPV and 75% accuracy. Mean ADC ratio in the pCR subgroup was significantly higher than that in the non-pCR subgroup (p= 0.003). A multivariate model including LE and ADC ratio predicted PR with an 85% accuracy (95% CI: 72%-97%).

CONCLUSION

Late enhancement and ADC ratio are independent predicting factors for pathologic response after NST in breast cancer.

CLINICAL RELEVANCE/APPLICATION

These results pose the possibility of omitting locorregional surgery in highly-selected groups of patients with HER2+ breast cancer who achieve pCR after NST demonstrated by absence of LE and high ADC ratio on MR imaging. Vacuum-assisted biopsy would be needed previously to confirm the predicted pCR.

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SSE03

Cardiac (Myocardial Ischemia and Viability: MRI)

Monday, Nov. 27 3:00PM - 4:00PM Room: S502AB

CA MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
J. Paul Finn, MD, Los Angeles, CA (*Moderator*) Speakers Bureau, Bayer AG; ; ;
Arthur E. Stillman, MD, PhD, Atlanta, GA (*Moderator*) Nothing to Disclose

Sub-Events

SSE03-01 First Human Application of a Prototype Non-Binary Myocardial Infarct Quantification Technique Accounting for Partial Volume Averaging: Technical Feasibility and Inter-Reader Assessment

Monday, Nov. 27 3:00PM - 3:10PM Room: S502AB

Participants
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PURPOSE

Binary threshold-based myocardial infarct (MI) quantification techniques ignore partial volume averaging, yielding substantial mischaracterization of MI. This study aimed to assess the technical feasibility of MI quantification using a prototype non-binary algorithm - percent infarct mapping (PIM) - in patients with suspected MI.

METHOD AND MATERIALS

Patients (n=171, 64±14y) referred for 1.5T cardiac MR were prospectively enrolled in this IRB-approved study. MRI protocol included late gadolinium enhancement (LGE) acquisition (in-plane 1.2×1.2mm2, echo/repetition time [TE/TR] 3.9/8.4ms; flip 25°), and post-contrast T1 mapping (MOLLI scheme 4(1)3(1)2; in-plane 1.56×1.56mm2; TE/TR 2.6/1.1ms; flip 35°). MI percentage (MI%) was quantified by two readers based on LGE images using manual delineation and binary approaches (2-5 standard deviations [SD] and full-width at half-maximum [FWHM] thresholds), as well as based on T1 and LGE images applying the previously described PIM algorithm (PIMT1 and PIMLGE, respectively) using an in-house developed application integrated into the Research Mass Software. Mann-Whitney and Bland-Altman (BA) tests were used for data analysis.

RESULTS

MI was observed in 89 (52%) patients and in 185 short-axis slices. MI% with binary 2, 3, 4, 5 SDs and FWHM techniques was 15.7±6.6, 13.4±6.8, 11.6±5.9, 10.9±5.5, and 10.1±5.9%, respectively. The 5SD and FWHM techniques showed the best agreement with manual MI delineation (9.9±6.1%, BA bias 1.3% and 1.2%, respectively). 2SD and 3SD algorithms, however, significantly overestimated manual MI% (P=0.0054 and P=0.0197, respectively). PIMLGE measured significantly lower MI% (7.9±4.8%) compared to manual measurements (P=0.0011). PIMLGE, however, showed the best agreement with the PIMT1 reference (7.6±4.9%, P=0.1084, BA bias 0.4%). Inter-reader agreement was high using all the algorithms (BA bias range 0.1-1.3%).

CONCLUSION

The human application of PIMLGE technique for MI quantification is feasible. As expected, PIMLGE provides significantly smaller MI% than any thresholding technique due to its ability to account for voxel-wise MI content. Additionally, it has excellent agreement with the T1-based, validated reference.

CLINICAL RELEVANCE/APPLICATION

PIMLGE is able to visualize and quantify the heterogeneity of MI providing further advantages in multiple clinical scenarios such as localizing post-MI arrhythmia foci and assessing potential myocardial salvage.

SSE03-02 Rest and Stress T1-Mapping and T1 Reactivity in Patients with and Without Coronary Artery Disease

Monday, Nov. 27 3:10PM - 3:20PM Room: S502AB

Participants
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PURPOSE

To demonstrate the possibilities of T1 mapping in rest and stress as a novel gadolinium-free method for tissue characterization discriminating normal and diseased myocardium in a patient group with or without coronary artery disease (CAD).

METHOD AND MATERIALS

We prospectively included patients who underwent stress perfusion as part of clinical work up due to suspicion of CAD. Conventional stress perfusion imaging and late gadolinium enhancement (LGE) were performed to identify perfusion defects and to discriminate ischemic and infarcted myocardium. The patients were divided into three groups, an ischemic group, an infarct group and a control group without perfusion defects. A Modified Look-Locker Inversion Recovery (MOLLI) based T1-mapping sequence was performed at both rest and in stress using a 1.5T MR system. A pixel-wise T1 map of the myocardium was acquired in short-axis view with inline motion correction. A single-shot steady-state free-precession readout was used to generate the images. The T1 maps were analyzed on commercial software. Short-axis T1 maps were manually contoured using conservative septal sampling , and specific sampling in ischemic or infarcted regions of interest (ROI) based on perfusion images and LGE images.

RESULTS

We included a total of 64 patients, 10 patients with ischemic myocardium, 15 patients with infarcted myocardium and 39 control patients. Heart rate increased in all three groups with the use of adenosine, but in the infarcted group the heart increased significantly less during stress compared to the control group. Pre-contrast native T1-values were significantly higher in infarcted myocardium in rest and stress (median 1044(IQR 985-1076) and 1053(IQR 989-1088)) compared to ischemic myocardium (median 961(IQR 939-988) and 958(IQR 945-988)). T1 reactivity was significantly lower in ischemic and infarcted myocardium (median 0.00 (IQR -0.18-0.16) and 0.41(IQR 0.09-0.86))compared to normal remote myocardium (median 3.54(IQR 1.48-5.78) and 3.21(IQR 1.95-4.79)).

CONCLUSION

In conclusion T1-mapping in rest and stress is able to distinguish between normal, normal remote, ischemic and infarcted myocardium using native T1 and T1 reactivity.

CLINICAL RELEVANCE/APPLICATION

Native T1 and T1 reactivity holds potential as a biomarker for tissue characterization in MR without the use of gadolinium.

SSE03-03 T1 Map-based Quantitative Inversion Time Prescription for Late Gadolinium Enhancement Outperforms Look-Locker-based Subjective Inversion Time Estimation

Monday, Nov. 27 3:20PM - 3:30PM Room: S502AB

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PURPOSE

Look-Locker (LL)-based subjective estimation of the inversion time (TI) ("TI-scout") for late gadolinium enhancement (LGE) imaging has multiple limitations. Our aim was to develop and test a T1 map-based synthetic inversion recovery (SyIR) technique allowing for the quantitative calculation of the optimal TI (TI0).

METHOD AND MATERIALS

Patients (n=78; 61±17y) referred for 1.5T cardiac MR were prospectively enrolled in this IRB approved study. LL TI-scout (in-plane 2.08×2.08mm2; echo/repetition time [TE/TR] 1.1/2.5ms; flip 50°; TI range 90-600ms) and T1-map (MOLLI scheme 4(1)3(1)2; in-plane 1.56×1.56mm2; TE/TR 1.1/2.6ms; flip 35°) were acquired at 12-min post-contrast in a random order. SyIR images were calculated from T1 maps in a TI range of 200-400ms. Two groups (Gr) were defined: GrLL (n=40; T1 map followed by LL, LL used for TI0 prescription for LGE) and GrT1 (n=38; LL followed by T1 map, T1-based SyIR used for TI0 prescription). Image quality

(quality of nulling, ability to differentiate enhanced myocardium from blood, and enhanced from normal) was rated (3-point Likert scale) and objectively measured. Groups were compared using the Kruskal-Wallis and Mann-Whitney tests.

RESULTS

LGE was observed in 45 (56.9%) subjects. TI0 was significantly shorter based on LL compared to T1-based SyIR (GrLL: 242±47ms vs. 286±56ms, P=0.0198; GrT1: 244±29ms vs. 285±32ms, P<0.0001). A significant difference was observed between LL-based TI0 and the actual TI applied for the LGE scan (242±47ms vs. 279±54ms, P=0.0009) due to the need to account for LL correction ("fudge factor"). This difference was not shown between SyIR TI0 and the actual TI used. LGE images based on SyIR TI0 had better image quality ratings compared to LL TI0-based LGE images for the quality of nulling (2.3 [2.0-2.6] vs. 1.8 [1.4-2.2], P=0.0027). There was no difference in the other subjective measures. Myocardial/background signal ratio was lower in GrT1 compared to the GrLL (1.2±0.4 vs. 2.4±1.1, P=0.0079).

CONCLUSION

T1-based SyIR imaging provides objective, quantitative, and real-time prescription of TI0 for LGE imaging; eliminating the need for LL correction and the substantial operator dependence of the acquisition ("fudge factor").

CLINICAL RELEVANCE/APPLICATION

The T1-based SyIR technique provides improved quality of myocardial signal nulling for LGE, retrospective TI0 selection, higher TI resolution, no need for LL correction or TI0 adjustment, and less operator dependence.

SSE03-04 Stress Perfusion CMR: Improved Correlation with Invasive Fractional Flow Reserve after Correction for Perfusion Changes in Remote Myocardium

Monday, Nov. 27 3:30PM - 3:40PM Room: S502AB

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PURPOSE

This study was undertaken, considering fractional flow reserve (FFR) as the reference: (i) to evaluate a predictive model of flow reserve using adenosine cardiac magnetic resonance (CMR) time-signal intensity measurements collected in the area distal to a focal coronary artery stenosis (CAS) and (ii) to assess the incremental value of correcting this model by including similar measurements in remote areas.

METHOD AND MATERIALS

This retrospective study was approved by the hospital ethics committee. Forty-six patients (mean age 61±9 years; 33 males) who underwent both adenosine first-pass CMR and FFR in the work-up for a focal CAS (n=49) were included after written informed consent. Areas-at-risk (RISK) and remote adenosine/rest time-signal intensity parameters were evaluated. Boosting models were elaborated to predict the FFR value from (i)the whole (extended) and (ii)RISK-only parameters. The relationship between the predictions and FFR value was described with Bland-Altman and summarized with intra-class correlation(ICC). Diagnostic accuracies of the models predicting FFR<=0.80 were calculated.

RESULTS

The average FFR value was 0.84±0.09 (0.60-0.98 range), 15(31%) were <=0.80. Decreasing FFR was associated with opposite effects on myocardial time-signal intensity responses downstream of the CAS or remotely. Compared to the RISK-only models, the extended models exhibited higher correlations with the FFR value (0.73;95%CI,0.57-0.84 versus 0.25;95%CI,0.03-0.50) and diagnostic accuracy to predict FFR<=0.80 CAS [44/49 (90%; 95%CI,78-98) vs 36/49 (73%;95%CI,55-88)].

CONCLUSION

When evaluating the functional significance of a CAS using adenosine first-pass CMR, considering time-signal intensity measurements in remote areas allows a better correlation with invasive FFR and improved diagnostic accuracy for FFR<=0.80.

CLINICAL RELEVANCE/APPLICATION

To improve the clinical relevance of evaluating coronary stenoses by using adenosine first-pass CMR, each perfusion-related parameter should be corrected by its value in remote segments.

SSE03-05 Assessment of Left-Ventricular-Wall Motion Disorders after Myocardial Infarction Using Compressed Sensing Real-Time Cine Imaging

Monday, Nov. 27 3:40PM - 3:50PM Room: S502AB

Participants
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PURPOSE

To evaluate the reliability of a compressed sensing (CS) real-time prototype cine sequence (Sparse 2D cine, Siemens Healthineers) for the detection of left ventricle (LV) wall motion disorders after myocardial infarction (MI) in clinical practice.

METHOD AND MATERIALS

Thirty consecutive adult patients (20 males, 10 females; mean age = 64.5 ± 13.4 years) referred for either initial work-up or follow-up by cardiac magnetic resonance (CMR) in the clinical context of MI were prospectively included. Each patient underwent the same CMR protocol: (a) the reference segmented multi-breath-hold steady-state free precession cine sequence including short-axis stack, one four-chamber slice, one two-chamber slice (Group 1) and (b) a CS real-time single-breath-hold sequence (Group 2) providing the same slice number, position and thickness. In both groups, wall motion disorders were independently and blindly assessed by two radiologists, based on the American Heart Association LV segmentation. Paired Wilcoxon signed-rank test was used to analyze the statistical difference. ROC study was performed to assess the differential diagnosis performance.

RESULTS

All patients presented at least one segmental wall motion abnormalities in Group 1 and in Group 2. In Group 1, among 510 segments analyzed, 278 (54.5%) had motion disorder described as hypokinesia (n= 147; 28.6%), akinesia (n= 124; 24.3%) or dyskinesia (n= 7; 1.4%). There was no significant difference regarding wall motion disorder description in Group 2 compared to Group 1 (p = 1.0) with a 98.92% sensitivity (95%CI [96.9-99.8]) and a 99.14% specificity (95%CI [96.9-99.9]). Area under the curve was 0.992 (95%CI [0.980-0.998]; p < 0.0001).

CONCLUSION

The single-breath-hold Compressed Sensing real-time cine imaging technique is a reliable sequence to assess wall motion abnormalities by CMR in the context of myocardial infarction.

CLINICAL RELEVANCE/APPLICATION

As patients suffering from MI may present shortness of breath, use of CS cine imaging can significantly reduce acquisition time without compromising detection accuracy of LV-wall motion disorders.

SSE03-06 Development of Cardiac Remodeling in Patients with Acute Myocardial Infarction Studied by Cardiac MRI (CMR)

Monday, Nov. 27 3:50PM - 4:00PM Room: S502AB

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PURPOSE

Left ventricular (LV) remodeling after acute myocardial infarction (AMI) is defined as an increase of left ventricular end-diastolic volume index (LVEDVi) >=15% within the first months after AMI. The purpose of this study was to analyze the exact course of LVEDVi and its relation to infarct size and LV ejection fraction.

METHOD AND MATERIALS

We performed CMR in 84 consecutive patients (mean age 56 years) with reperfused first AMIs to assess LV volumes, myocardial mass and function. Infarct size was obtained by late gadolinium enhancement (LGE) CMR. Patients underwent the baseline CMR 7 ±4 days after AMI. Follow-up scans were performed after 6.5 ±1.5 weeks, 3.5 ±0.6 months and 6.7 ±1.4 months. An increased LVEDVi was defined as >97 mL/m2 in males and >90 mL/m2 in females.

RESULTS

Two distinct different types of LV remodeling were observed. Twenty-one of 84 patients (25%) showed a classic remodeling with normal LVEDVi at baseline (76 ±13 mL/m2), which significantly increased to 89 ±19 mL/m2 at 7 week (P<0.05) and than remained stable. Thirteen patients (16%) showed early remodeling with an increased LVEDVi of 112 ±14 mL/m2 at baseline and no further change of LVEDVi during follow-up. Infarct size of patients with early remodeling (22 ±7 %LV) and classic remodeling (19 ± 9 %LV) were larger compared to patients without remodeling 12 ±9 %LV, (P<0.01). At baseline, patients with early remodeling had a significantly lower ejection fraction (EF) with 42 ±9 % compared to patients with classic (55 ±13%, P<0.01) and to patients with no remodeling (57 ±10 %, P<0.01). Patients with early remodeling had no recovery of EF during follow-up (45 ±5 %, P=ns).

CONCLUSION

Besides classic remodeling, 16% of our patients showed early remodeling, which is characterized by immediate LV dilatation after AMI and initially severely reduced EF with no recovery during follow-up.

CLINICAL RELEVANCE/APPLICATION

Patients with early remodeling may represent a subgroup of patients at higher risk for heart failure and sudden cardiac death, requiring more intensive treatment to prevent these events.

SSE04

Cardiac (Coronary Artery Disease: General I)

Monday, Nov. 27 3:00PM - 4:00PM Room: S504AB

CA CT MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSE04-01 Improving the Degree and Uniformity of Enhancement in Coronary CT Angiography with a New Bolus Tracking Method Enabled by Free Breathing

Monday, Nov. 27 3:00PM - 3:10PM Room: S504AB

Participants
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PURPOSE

To demonstrate the improved degree and uniformity of enhancement in coronary CT angiography (CCTA) on a 16cm wide-coverage CT with a new bolus tracking method enabled by free breathing, in comparison with the conventional method with breath holding.

RESULTS

The mean enhancement in vessels in Group A (412.7±55.3HU) was higher than in Group B (337.6±72.7HU) ($P<0.05$). The fluctuation rate for the enhancement was lower in the free breathing group in AS (13.4%), RCA (16.4%), LAD (19.5%) and LCX (16.7%) than in the breath holding group (21.5%, 20.8%, 21.5% and 26.2%, respectively) (all $P<0.05$). There was no significant difference in image quality score, SD, SNR, CNR between the two groups.

CONCLUSION

A new bolus tracking method enabled by free-breathing in CCTA on 16cm wide-coverage CT system increases the enhancement degree and uniformity in coronary arteries, compared with the conventional triggering method.

CLINICAL RELEVANCE/APPLICATION

Free-breathing CCTA can increase the enhanement effect of coronary artery, provide us a consistency enhancement effect image, and improved the overall image quality.

SSE04-02 The Effect of the Motion Correction Algorithm on the Image Quality of Coronary CT Angiography with Fast kVp Switching Single Source Dual-Energy CT at the Reconstructed Various Cardiac Phases

Monday, Nov. 27 3:10PM - 3:20PM Room: S504AB

Participants
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PURPOSE

To investigate the effect of the motion correction algorithm (SnapShot Freeze: SSF; GE Healthcare) on the image quality at various cardiac phases in coronary CT angiography (CCTA) with fast kVp switching single source dual-energy CT (ssDECT).

METHOD AND MATERIALS

Twenty five patients with heart rate below 65 bpm (42 - 65 bpm) who underwent CCTA using ECG-gated axial step-and-shoot with dual-energy scan mode on a 64-row ssDECT (Revolution GSI; GE Healthcare) were included. For the CCTA scan, we used the scan parameter as follows; tube voltage: 80/140 kVp fast switching, rotation time: 0.35 s/rot, and tube current was determined 375 mA or 600 mA or 640 mA based on patient BMI (CTDIvol was 36.7 ± 8.3 mGy). Cardiac axial images were reconstructed with and without SSF at the cardiac phases of 60% to 90% with 5% interval. Two readers graded the image quality of the 4 major coronary arteries (right coronary artery: RCA, left main trunk: LMT, left arterial descending artery: LAD, and left circumflex: LCX) reconstructed with and without SSF by using 5-point scores (5, no motion artifacts; 4, minor artifacts; 3, moderate artifacts; 2, severe artifacts; 1, image not evaluated and vessel structures not differentiable) with consensus and score above 3 was defined as diagnostic acceptable vessel. Average scores of the per-vessel and the per-segment in each cardiac phase were compared between reconstruction with and without SSF by using Wilcoxon signed rank test.

RESULTS

In all cardiac phase, average scores of SSF were higher than that of without SSF in the all vessels and the all segments (with SSF: 3.6±0.9, without SSF: 3.2±0.9, P<0.01). Without SSF, cardiac phases that coronary vessel was diagnostic acceptable were from 65% to 80% in RCA, 60% to 85% in LMT, 60% to 85% in LAD, 65% to 80% in LCX. With SSF, those cardiac phases were 60% to 80% in RCA, 60% to 90% in LMT, 60% to 85% in LAD, 60% to 85% in LCX. Diagnostic acceptable cardiac phase for all vessels was 65% to 80% without SSF, and 60% to 85% with SSF.

CONCLUSION

SSF controlled the motion artifact and improved image quality of CCTA with fast kVp switching ssDECT. In addition, SSF extended the diagnosable range of reconstructed cardiac phases.

CLINICAL RELEVANCE/APPLICATION

Motion correction algorithm (SSF) in coronary CT angiography with fast kVp switching dual-energy CT was useful to reduce the motion artifacts and extend diagnostic acceptable cardiac phase.

SSE04-03 Single-Phase Coronary Artery CT Angiography Extracted From Stress Dynamic Myocardial CT Perfusion on a Third-Generation Dual-Source CT: Validation by Coronary Angiography

Monday, Nov. 27 3:20PM - 3:30PM Room: S504AB

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PURPOSE

To investigate the image quality (IQ) and diagnostic performance of single-phase coronary CT angiography (SP-CCTA) images extracted from stress dynamic myocardial CT perfusion (CTP) scans using third-generation dual-source CT (DSCT).

METHOD AND MATERIALS

The institutional review board approved the study and written informed consent was obtained from all patients. Consecutive symptomatic patients who met appropriateness criteria for cardiac CT were prospectively recruited and scanned with adenosine triphosphate-stress dynamic myocardial CTP and routine CCTA protocol using third-generation DSCT. Images from the phase of the CTP scan with the best enhancement of the coronary arteries were selected as the SP-CCTA. Baseline characteristics and IQ results were assessed. Coronary angiography (CAG) was used as a reference standard, the diagnostic accuracy for stenosis >=50% detection was compared with SP-CCTA and routine CCTA.

RESULTS

51 patients successfully underwent the combined ATP-stress dynamic myocardial CTP and CCTA examination, among which 34 patients underwent CAG. The mean heart rate during stress CTP was much higher than that during CCTA (85.0±12.7 and 67.9±10.0 bpm, p<0.001). The qualitative IQ scores of SP-CCTA were similar to that of routine CCTA (p>0.05). On a per-vessel basis, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the curve results of SP-CCTA and routine CCTA for diagnosis of stenosis >=50% exhibit no significant difference (SP-CCTA: 95.0%, 86.0%, 84.4%, 95.6%, 0.841; routine CCTA: 92.1%, 88.5%, 85.4%, 93.9%, 0.829; all P>0.05). The mean effective radiation dose (ED) of CTP and routine CCTA plus CTP were 3.92±1.72mSv and 5.98±2.01mSv (P<0.05), respectively.

CONCLUSION

With third-generation DSCT, the IQ and diagnostic value of SP-CCTA was equivalent to routine CCTA. It is potentially feasible to replace a separate routine CCTA acquisition with SP-CCTA images extracted from stress dynamic myocardial CTP.

CLINICAL RELEVANCE/APPLICATION

The single-phase CCTA derived from CTP with the third-generation dual-source CT is able to replace the routine CCTA scan and create highest possibilities for "one-stop" cardiac CT examination, which allowing patients in need of myocardial blood flow assessment to benefit from it.

SSE04-04 Participants

3D Fusion of Coronary CT Angiography and CT Myocardial Perfusion Imaging: One-Stop-Shop Assessment of Morphology and Function

Monday, Nov. 27 3:30PM - 3:40PM Room: S504AB

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PURPOSE

To develop a software tool for 3D fusion imaging of CT coronary angiography (CTCA) and CT myocardial perfusion imaging (CTPerf), intuitively visualizing relevant coronary artery stenoses and corresponding myocardial perfusion deficits for diagnostics of coronary artery disease (CAD).

METHOD AND MATERIALS

12 patients underwent CTCA and CTPerf after heart transplant in this prospective study (mean age 56±12 years, range 32-76 years, all males, scan date 08/2015-03/2016). CT image quality was rated. Coronary diameter stenoses >50% were documented for CTCA. Adenosine stress-induced perfusion deficits were noted for CTPerf. A software tool was implemented to allow for 3D fusion imaging of both datasets. Coronary arteries and heart contours were segmented in a fully automatic fashion using centerline or model-based region growing algorithms, respectively. To overcome registration mismatch due to different heart phases of CTCA/CTPerf image acquisition, myocardial perfusion values were mathematically projected on the CTCA left ventricle. 3 resulting datasets (i.e., coronary tree, heart contour, and perfusion values) were fused for 3D multiparametric volume rendering. Either endocardial, transmural, or epicardial average perfusion values could be visualized. 3D fusion was compared to CTCA/CTPerf side-by-side analysis and results from catheter CA.

RESULTS

CT image quality was rated as good-excellent (mean score 3.6±0.5, scale 1-4). In 5/12 patients (41%), manual heart phase adjustment used for automatic segmentation was required. Subsequent 3D fusion imaging was successfully feasible in all cases (12/12, 100%). 2/12 patients (17%) showed stress-induced perfusion deficits. Ischemic regions could be intuitively correlated to culprit coronary lesions in both cases (2/2, 100%). Results from 3D multiparametric volume rendering approved coronary assignment of side-by-side analysis and were in full correspondence with findings from catheter CA.

CONCLUSION

A software framework for 3D CTCA/CTPerf fusion imaging was developed, advancing a CT one-stop-shop multiparametric CAD diagnostic procedure for patients being not able to undergo CMR perfusion imaging due to MRI contraindications.

CLINICAL RELEVANCE/APPLICATION

For diagnostics of CAD, assessment of coronary artery stenosis and myocardial ischemia are equally important. 3D fusion of CTCA and CTPerf eases the assignment of anatomical to functional information.

SSE04-05 Single Breath-Hold Whole-Heart Unenhanced Coronary MRA Using Multi-Shot Gradient Echo EPI with 3T MRI: Comparison with Free-Breathing TFE Coronary MRA in Healthy Volunteers

Monday, Nov. 27 3:40PM - 3:50PM Room: S504AB

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PURPOSE

The single breath-hold technique for coronary magnetic resonance angiography (MRA) can shorten the total scan time and reduce the influence of respiratory motion. However, unenhanced whole heart coronary MRA at 3T MRI is still challenging because of increased B0 inhomogeneity compared with 1.5T MRI. Here we investigated the feasibility of single breath-hold unenhanced coronary MRA using multi-shot gradient echo planar imaging (MSG-EPI) with a 3T-scanner.

METHOD AND MATERIALS

14 volunteers underwent single breath-hold coronary MRA with MSG-EPI and free-breathing turbo field echo (TFE) coronary MRA at 3T. The acquisition time, signal to noise ratio (SNR), and the contrast of the sequences were compared using paired t-tests. Readers evaluated the image contrast, noise, sharpness, artifacts, and overall image quality.

RESULTS

The acquisition time was 88.1% shorter for MSG-EPI than TFE (24.7 ± 2.5 vs 206.4 ± 23.1 sec, $p < 0.01$). The SNR was significantly higher on MSG-EPI than TFE scans ($p < 0.01$). There was no significant difference in contrast between MSG-EPI and

TFE scans (1.8 ± 0.3 vs 1.9 ± 0.3, p = 0.24). There was no significant difference in image contrast, image sharpness, and overall image quality between the two scanning techniques. The scores for image noise and artifacts were significantly higher on MSG-EPI than TFE scans ($p < 0.05$).

CONCLUSION

The single breath-hold MSG-EPI sequence is a promising technique for shortening the scan time and preserving the image quality of unenhanced whole-heart coronary MRA with 3T MRI.

CLINICAL RELEVANCE/APPLICATION

The MSG-EPI sequence with a 3T MRI scan provides adequate quality for single breath-hold unenhanced coronary MRA, compared with the conventional TFE sequence.

SSE04-06 Effects of Coronary Stents on Phase Contrast Flow Measurements in Cardiovascular MRI: Phantom Study

Monday, Nov. 27 3:50PM - 4:00PM Room: S504AB

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PURPOSE

The evaluation of restenosis after coronary stent implantation is important for management after treatment. Assessing coronary flow reserve using phase contrast MRI has potential for the noninvasive detection of coronary artery stenosis, including in-stent restenosis. However, in patients with stents, metallic compounds often evoke image artifacts, such as phase alterations and image distortions of the magnetic field. The purpose of this study was to evaluate influences according to various types of stents (different material and cell design) on phase contrast measurements in a phantom study.

METHOD AND MATERIALS

Three stents (MULTI-LINK VISION, Nobori, and Ultimaster) from varying material and cell designs were placed in a flow phantom. Phase contrast measurements were acquired with a 1.5 T MR scanner using conventional gradient-echo sequences proximal and distal to the stent at a predefined distance (every 3mm from the stent's distal edge). Scan parameters were as follows: temporal resolution 47ms, TE 4.2ms, TR 7.0 ms, slice thickness 5mm, flip angle 30 degrees, and in-plane resolution 1.7x3.0mm. In each stent, results (peak velocity and average flow per second) were compared to measurements with a reference flow at the proximal level without any stents.

RESULTS

Flow results distal to the stent differed significantly from the reference flow (25.8cm/sec and 7.02ml/sec) acquired at the proximal level of the stent according to the stent type. The maximum flow miscalculation of peak velocity and average flow per second was -10.95cm/sec and +3.52ml/sec for MULTI-LINK VISION, -23.84cm/sec and -5.86ml/sec for Nobiri, and+2.00cm/sec and -0.35ml/sec for Ultimaster. For MULTI-LINK VISION and Ultimaster, flow values measured approximately 3mm distal to the level of the stent agreed with the reference flow. For Nobiri, flow values measured approximately 12mm were effective.

CONCLUSION

Tested coronary stents led to a significant deviation of measured flow rates compared to a reference. A distance effective to avoid this influence should be adjusted according to the stent type.

CLINICAL RELEVANCE/APPLICATION

For flow measurements of the coronary artery after stent implantation, a distance effective to avoid the deviation of measured flow due to a stent should be adjusted according to the stent type.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
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SSE05

Chest (Emphysema and Airways)

Monday, Nov. 27 3:00PM - 4:00PM Room: S404CD

BQ CH CT

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSE05-01 A Thin Walled Small Lumen CT-Based Airway Phenotype Identified within the SPIROMICS Cohort

Monday, Nov. 27 3:00PM - 3:10PM Room: S404CD

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PURPOSE

We have sought to understand the role of reconstructed computed tomographic (CT) field of view (DFOV) on airway wall thickness within the NIH sponsored subpopulations and intermediate outcome measures in COPD study (SPIROMICS). In doing so, we have identified a subphenotype with thin walled small lumen (TWSL) central airways. We explored the clinical and demographic differences between the TWSL and non-TWSL groups.

METHOD AND MATERIALS

2937 baseline full inspiratory (TLC) and expiratory (RV) CT data sets were evaluated within the full SPIROMICS cohort of smokers with and without COPD and non-smokers. A scatter plot of wall thickness vs. DFOV was plotted for the trachea and right mainstem bronchus (RMB). Two distinct clusters were identified at each location. A linear discriminator algorithm was used to calculate the line separating two clusters. 426 TWSL vs. non-TWSL clinical and demographic comparisons were made via t-tests using conservative Bonferroni correction to keep significance level at $p < .05$. The same method was used to compare CT density-histogram-based measurements.

RESULTS

The line separating TWSL vs. non-TWSL is: WT (mm) = 6.24e-03 DFOV (mm) + 7.77e-02. Subjects below the line at the trachea or the RMB are termed: TWSL. 118 (4%) of subjects were TWSL at the trachea. An additional 932 ((118+932)/2937=35%) were TWSL at RMB. Amongst the 426 clinical and demographic comparisons between RMB-TWSL vs non-TWSL, 103 were significant. The lumen area between TLC and RV was more stable in the TWSL group. The TWSL group is female dominant (P=1.66E-15), six minute walk distance is less (P=4.43E-12) BMI is greater. (P=1.52E-41). Other differentiators include: History of asthma, FEV1, BODE Index, and MRC-defined shortness of breath, all of which are greater in TWSL. The TWSL group had significantly more dense lung regions (>-650HU) and less CT-defined emphysema (<-950Hu) compared with the non-TWSL group.

CONCLUSION

TWSL subjects within the smoking population differentiate from non-TWSL both demographically as well as clinically. The TWSL group have significant airway pathology-associated symptoms coupled with less emphysema and a greater portion of dense lung.

CLINICAL RELEVANCE/APPLICATION

A thin walled and small lumen (TWSL) airway phenotype has been identified which, in a smoking population, is distinct in terms of

demographics, clinical pathophysiology and CT-density characteristics.

SSE05-02 Predictors of Treatment Response in COPD Patients at 1-Year Follow-Up: Value of Advanced CT Quantification

Monday, Nov. 27 3:10PM - 3:20PM Room: S404CD

Awards
Student Travel Stipend Award

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PURPOSE

To investigate predictive factors of treatment response in COPD patients at 1-year follow-up using advanced quantitative CT analyses.

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board with waiver of informed consent. 258 patients (240 men and 18 women; mean age, 66.0 years ± 8.0) were selected from Korean Obstructive Lung Disease (KOLD) cohort, who underwent baseline chest CT, initial and 1-year follow-up pulmonary function test (PFT) during treatment. Patients received combined inhalation of long-acting beta-agonist and corticosteroid. From volumetric CT data, emphysema index, airway trapping index (ATI), and small airway parameter (AWT-Pi10) using both full-width-half-maximum (FWHM) and integral-based half-band (IBHB) methods were obtained. ATI measurements were acquired by using thresholds of -856HU on expiratory CT (ATI_-856) and by using co-registration (ATI_emphysema, ATI_hyperinflated, ATI_normal, respectively). The clinically meaningful treatment response was defined as an absolute increase of at least 0.225L on follow-up PFT. Multiple logistic regression analysis was performed to identify predictive factors of treatment response

RESULTS

Treatment responders were 41 patients (15.9%). The mean increase in FEV1 was 0.38 ± 0.17 L. Univariate analysis showed that age, initial 6-minite walk distance (6MWD), initial DLCO, emphysema index, ATI_emphysema and Pi10_IBHB were significantly different between patients with and without treatment response (P= 0.008. 0.001, 0.002, 0.004, 0.001 and <0.001, respectively). Multivariate analysis revealed that 6MWD and Pi10_IBHB were independent variables predictive of FEV1 increase (P= 0.001 and <0.001, respectively). The adjusted odds ratio was 1.008 (95% CI, 1.003-1.012) and 5.439 (95% CI, 2.069-14.301) respectively. Receiving operating characteristic curve showed that area under the curve of these two variables was 0.715.

CONCLUSION

Accurate measurement of Pi10 by IBHB methods may help predict treatment outcome of COPD at 1-year follow-up.

CLINICAL RELEVANCE/APPLICATION

Application of advanced CT quantification with acute measure of small airway dimension has been shown to accurately evaluate treatment outcome of COPD; thus, it can be considered to be used in routine clinical practice.

SSE05-03 Inspiratory/Expiratory Xenon-Enhanced Area-Detector CT (ADCT): Utility for Regional Ventilation, Pulmonary Functional Loss and Clinical Stage Evaluations of in Smokers

Monday, Nov. 27 3:20PM - 3:30PM Room: S404CD

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PURPOSE

To evaluate the utility of xenon (Xe) ventilation assessment on inspiratory/expiratory Xe-enhanced area-detector CT (ADCT) for regional ventilation, pulmonary functional loss and clinical stage evaluations in smokers.

METHOD AND MATERIALS

Forty consecutive smokers prospectively underwent inspiratory/expiratory xenon-enhanced ADCT examinations as well as pulmonary function tests. Then, all smokers were classified by GOLD classification based pulmonary function test results. Each CT data was transferred to our proprietary software to generate Xe wash-in (WI), wash-in/wash-out (=WI/WO) ratio and ventilation (=[WI-WO]/WI) ratio maps between inspiratory/expiratory CT scans by pixel-by-pixel analyses. According to the previous study, each pixel within the lung was divided into three lesion groups as follows: normal lung, functional small airway disease (fSAD) and emphysema. To determine regional ventilation differences, each Xe ventilation index was compared three groups by Tukey's HSD test. To evaluate the capability for pulmonary function loss assessment, step-wise regression analyses were performed among all Xe ventilation indexes and pulmonary function test results such as %FEV1 and FEV1/FVC%. Finally, discrimination analysis was performed to determine the concordance capability for GOLD stage classification was also determined.

RESULTS

WI and ventilation ratio had significant difference among three lesion groups ($p<0.05$) and WI/WO ratio of emphysema had significant difference with that of others ($p<0.05$). %FEV1 ($r2=0.71$, $p<0.05$) and FEV1/FVC% ($r2=0.71$, $p<0.05$) were significantly affected by ventilation ratio as 1st step and WI as 2nd step. With all Xe ventilation indexes, the concordance capability for GOLD classification was determined as 87.5 (35/40) %.

CONCLUSION

Xenon ventilation assessment on inspiratory/expiratory xenon-enhanced ADCT was useful for regional ventilation, pulmonary functional loss and clinical stage evaluations in smokers.

CLINICAL RELEVANCE/APPLICATION

Xenon ventilation assessment on inspiratory/expiratory xenon-enhanced ADCT was useful for regional ventilation, pulmonary functional loss and clinical stage evaluations in smokers.

SSE05-04 Visual Emphysema Pattern Using the Fleischner Society Classification System Is Independently Associated with Mortality in Cigarette Smokers

Monday, Nov. 27 3:30PM - 3:40PM Room: S404CD

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PURPOSE

Visual categorization of pattern of emphysema on CT has been shown to correlate with symptomatic impairment. However, the relationship between pattern of emphysema and mortality has not previously been evaluated.

METHOD AND MATERIALS

Of the first 4000 subjects consecutively enrolled in the COPDGene study, 3171 had availability of both visual CT scores and survival information. Trained research analysts performed visual classification of parenchymal emphysema, paraseptal emphysema, and airway wall thickening, on baseline volumetric CT scans of these subjects using the Fleischner Society classification system. Each scan was independently evaluated by two analysts; discordances between analysts were adjudicated by a thoracic radiologist. Severity of emphysema was evaluated quantitatively using % low attenuation < -950 HU (LAA-950). Median duration of follow-up was 6.9 years (range 30 days to 8.5 years). Regression analysis of the relationship between imaging patterns and survival was based on the Cox proportional hazards model, with adjustment for age, race, gender, height, weight, pack-years of cigarette smoking, current smoking status, educational level, and LAA-950, and (in a second model) FEV1.

RESULTS

Observer agreement for presence and pattern of parenchymal emphysema was good to excellent. There were 519 deaths in the group. Compared with subjects who did not have visible emphysema, mortality was significantly greater in those with all grades of CLE (except for trace), with adjusted hazard ratios of 1.8 for mild centrilobular emphysema, 2.5 for moderate centrilobular emphysema, 4.8 for confluent emphysema, and 3.8 for advanced destructive emphysema. This increased mortality persisted after further adjustment for LAA-950 and FEV1, except for those with advanced destructive emphysema.

CONCLUSION

The presence and pattern of parenchymal emphysema according to the Fleischner Society grading system is associated with significantly increased mortality risk, independent of the quantitative severity of disease measured by LAA-950.

CLINICAL RELEVANCE/APPLICATION

Visual evaluation of emphysema pattern is an important novel marker of mortality risk.

SSE05-05 Reconstructed Field of View Affects CT-based Pulmonary Airway Wall Metrics and Must be Accounted for in Assessments of Male-Female Differences

Monday, Nov. 27 3:40PM - 3:50PM Room: S404CD

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PURPOSE

It is well-established that gender has a significant effect on airway wall thickness. Males tend to have thicker airway walls than their female counterpart. However, in analyzing the role of reconstructed computed tomographic (CT) display field of view (DFOV) on airway wall thickness within the NIH sponsored subpopulations and intermediate outcome measures in COPD study (SPIROMICS) we have identified that this gender effect is confounded with the thickening of airway wall metrics with increased DFOV.

METHOD AND MATERIALS

2818 baseline full inspiratory CT data sets were evaluated within SPIROMICS (smokers and nonsmokers with a full range of COPD status, 40-80 years, 46% Females). Airway wall thickness is selected as the response variable. A generalized Additive Model(GAM) is adopted for the analysis which, compared to the commonly used multi-variate regression, is more robust and flexible in modeling nonlinear relationships between the response variable and its predictors. Two models with DFOV and without DFOV are implemented to see the confounding effect on gender differences. Moreover, Age, Race, BMI, Weight, Height, Scan site, and GOLD status are also considered as confounders in the model.

RESULTS

A total of 22 spatially matched airway segments are analyzed across all subjects. The table depicts the percentage decrease of airway wall thickness for females using males as the baseline before and after adjustment for DFOV. Gender effect is reduced for all segments after adjusting for DFOV, even though the effect varies across different airways, on average adjustment for DFOV reduces the effect of gender by 49.8%. In the case of tracheal wall thickness, the adjusted R2 is increased from 62% to 76% which implies that adding DFOV as a confounder leads to a better model fit.

CONCLUSION

Although females have thinner airway walls, the effect is halved when the measurement are corrected for DFOV.

CLINICAL RELEVANCE/APPLICATION

DFOV of CT reconstructions must be taken into account when assessing population differences in airway wall thickness and when assigning clinical meaning to measures of airway wall thickness.

SSE05-06 Distribution and Change of Parametric Response Map in Patients with Chronic Obstructive Pulmonary Disease: Cross-Sectional and Longitudinal Aspects

Monday, Nov. 27 3:50PM - 4:00PM Room: S404CD

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PURPOSE

To evaluate distribution and change of emphysema and regional air trapping by parametric response mapping (PRM) in chronic obstructive pulmonary disease (COPD) patients according to cross-sectional and longitudinal aspects .

METHOD AND MATERIALS

Inspiration and expiration CT scans from 224 subjects (mean age, 65.3 years; M : F = 214 : 10) in COPD cohorts were acquired at baseline and 3 years from the baseline. PRM was performed in all CT scans and classified lung parenchyma as normal (PRMNormal), emphysematous (PRMEmph), and functional small airway disease (PRMfSAD) using the co-registration method of inspiration and expiration CTs and two thresholds (-950 HU and -856 HU). Calculation of the center of distribution that is the median value for both axes and principal eigenvector of the data determined by the principal component analysis were obtained in each patient. After obtaining the center of distribution on CT at baseline and 3years, we indicated disease progression as a vector from the centroid at baseline to the centroid at 3 years per patient.

RESULTS

The distribution of GOLD stages at baseline were stage I in 31 patients, stage II in 121 patients, stage III in 63 patients, and stage IV in 9 patients. At 3 years follow-up, there were stage I in 36 patients, stage II in 116 patients, stage III in 52 patients, and stage IV in 7 patients. On based on pulmonary function tests, 147 patients (65.6%) showed stable GOLD stage while there were aggravation in 26 patients (11.6%) and improvement 38 patients (17.0%), respectively. Principal eigenvectors at baseline and 3 years from the baseline showed the tendency that fSAD was a transitional phase from normal parenchyma to emphysema. The vectors from the centroid at baseline to the centroid at 3 years per patient also demonstrated that functional small airway disease precedes emphysema.

CONCLUSION

PRM of chest CT in COPD patients appears to be a valuable tool in understanding disease progression and evaluating disease status.

CLINICAL RELEVANCE/APPLICATION

Cross-sectional and longitudinal analyses of COPD patients with parametric response map may provide supporting evidences that functional small airway disease precedes emphysema.

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SSE06

Emergency Radiology (Chest and Forensic Radiology)

Monday, Nov. 27 3:00PM - 4:00PM Room: N228

CH CT ER

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSE06-01 Clinical Postmortem Computed Tomography Can Demonstrate the Cause of Death or Guide the Autopsy

Monday, Nov. 27 3:00PM - 3:10PM Room: N228

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PURPOSE

To investigate the potential of postmortem CT (pmCT) to improve the clinical diagnosis of cause of death.

METHOD AND MATERIALS

86 cadavers underwent whole-body pmCT before conventional autopsy. Radiologists and pathologists were blinded to each other's results and compiled their own reports. Differences in the number of correctly identified clinical diagnoses, prior and post pmCT, as to the cause of death, type of pathology and anatomical system involved, were investigated by McNemar tests, with autopsy as the reference standard.

RESULTS

Using pmCT, the number of correctly identified causes of death, type of pathology and anatomical system involved increased from 53% to 64% (p=0.05), from 65% to 83% (p=0.001) and from 65% to 84% (p=0.001) respectively. The subgroup of cardiovascular causes of death showed almost the lowest sensitivity (54%) for cause of death after pmCT, but the most significant increase in sensitivity for anatomical system, from 62% to 82% (p=0.02) using pmCT.

CONCLUSION

Postmortem CT significantly improves clincial diagnosis as to the cause of death. If the exact cause of death is uncertain after pmCT, radiologists can indicate a particular region of interest, directing pathologists, which in turn may be able to reduce the invasiveness of a conventional autopsy.

CLINICAL RELEVANCE/APPLICATION

Due to decreasing autopsy rates, determination of cause of death relies heavily on clinical assessment. Postmortem CT significantly improves clinical diagnosis as to the cause of death. Used as a pre-autopsy screening, it may be able to reduce the invasiveness, or eliminate entirely, a conventional autopsy.

SSE06-02 Role of CT in the Personal Identification of Cadavers in Mass Disaster: Our Experience in Shipwrecked Migrants

Monday, Nov. 27 3:10PM - 3:20PM Room: N228

Awards
Student Travel Stipend Award

Participants
Federica Vernuccio, MD, Palermo, Italy (*Presenter*) Nothing to Disclose
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PURPOSE

To show the enormous contribution of CT in personal identification of migrants in the deadliest Mediterranean shipwreck occurred in April 2015, when a boat with about 700 migrants hoping to reach Sicily drowned off Libyan waters.

METHOD AND MATERIALS

In July 2016, 149 body bags of cadavers of the about 700 migrants were scanned through an 8-channels mobile CT placed next to the tents where coroners, antropologists and police forces were performing forensic studies. One of the main efforts of the team was the personal identification of the migrants; the radiological tools for personal identification have been studied and assessed mixing the different figures' expertise.

RESULTS

The radiological CT tools that proved to be useful for personal identification were:- age estimation: evaluation of bone growth plates (clavicle, scapula, humerus, radium, ulna, pelvic bones, femur, tibia and fibula) and of dental growth (mainly the third molar)- sex determination: evaluation of residual genitalia and of pelvic bones (morphology and angles)- stature estimation through the measurement of long limb bones lenght as the distance between the highest point of the caput femoris and the lowest point of the medial condyle were measured-pre-existing pathological conditions (i.e. fractures, bone diseases)- dental profile assessment-personal belongings (i.e. wallet, razors)Thus, a radiological template to be used in this kind of mass disaster has been created.

CONCLUSION

CT provides an important contribution in personal identification of cadavers in mass disaster and the knowledge of its strenghts and limits in this field is mandatory when approaching to it.

CLINICAL RELEVANCE/APPLICATION

Presentation of the strenghts and limits of CT for personal identification in mass disaster showing its usefulness as added tool to anthropological and autoptic assessment for age estimation and sex determination.

SSE06-03 Thoraco-Abdominal Injuries of Manual and Load-Distributing Band Cardiopulmonary Resuscitation on Postmortem Computed Tomography

Monday, Nov. 27 3:20PM - 3:30PM Room: N228

Participants
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Mathias Prokop, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Speakers Bureau, Bayer AG; Speakers Bureau, Bracco Group; Speakers Bureau, Toshiba Medical Systems Corporation; Research Grant, Toshiba Medical Systems Corporation;
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PURPOSE

To compare thoraco-abdominal post-resuscitation injuries between manual and load-distributing band (LDB) cardiopulmonary resuscitation (CPR) on postmortem Computed Tomography (CT).

METHOD AND MATERIALS

Patients with a thorax-abdomen postmortem CT, performed between July 2012 and December 2016, were classified into three groups: 1) deaths with LDB CPR, 2) deaths with manual CPR and 3) death without CPR. Patients with recent trauma, incomplete thorax-abdomen scanning procedures or below eighteen years of age were excluded. The scans were retrospectively reviewed for anterolateral and posterior rib fractures, sternal and vertebral fractures, pneumothorax, pleural fluid, hemothorax, epigastric effusion, abdominal free air and peri-organic abdominal fluid or hemorrhages. Chi-square and Mann-Whitney U tests were used to test for significant differences between the LDB and manual CPR group, and between the resuscitated and the non-resuscitated group.

RESULTS

The LDB group (n=38) showed more often (63% vs. 21%, p=0.001) a posterior rib fracture than the manual CPR group (n=29). Compared to the non-resuscitated group (n=58), the resuscitated group showed more often an anterolateral (88% vs. 9%, p<0.001) and posterior (45% vs. 0%, p<0.001) rib fracture, more anterolateral fractured ribs per patient (4 vs. 10, p=0.003), more often a sternal fracture (52% vs. 2%, p<0.001), epigastric effusion (42% vs. 7%, p<0.001) and less pelural fluid (14mm vs. 34mm, p=0.002), if present.

CONCLUSION

In unsuccessful resuscitations, the use of LDB CPR resulted in more posterior rib fractures than manual CPR. CPR in general, either manual or LDB, led to more rib and sternal fractures and more epigastric effusion.

CLINICAL RELEVANCE/APPLICATION

CPR leads to more fractures and organ injury than no CPR. Even more posterior rib fractures are observed when LDB CPR is used instead of manual CPR. Post-CPR injuries are comparable to high-energy trauma. This is important knowledge for caretakers of survivors, leading to more specific treatment and an argument to perform a CT scan in survivors.

SSE06-04 CCTA in Patients with Positive Troponin and Low Clinical Suspicion for ACS: A Useful Diagnostic Option to Exclude Obstructive CAD

Monday, Nov. 27 3:30PM - 3:40PM Room: N228

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Traditional algorithms in the management of ACS dictate that patients with a positive troponin should be admitted to hospital and undergo invasive coronary angiography (ICA). A recognized proportion of these patients will have no evidence of coronary artery disease (CAD) on ICA. In this study we report the CCTA findings in a carefully selected subgroup of patients with positive troponin who have low clinical suspicion for ACS.

METHOD AND MATERIALS

IRB approved retrospective analysis of 491 consecutive patients referred for CCTA between 04/04/2015 to 04/02/2017. All scans were performed on a dual source CT scanner in the emergency department of a level I trauma centre. Charts were reviewed for first positive troponin (TnI > 0.045 µg/L, Siemens Dimension Vista Flex® CTNI; Newark, USA) within 24 h prior imaging. 108 patients met inclusion criteria; 14 were excluded due to technical factors or substantial motion artifact. Statistical analysis was performed using Student's t-test with Prism 6 for Mac OS X version 6.0c (La Jolla, USA).

RESULTS

94 patients (55 men, 39 women) with a mean TnI of 2.22 ± 2.82 µg/L underwent CCTA an average of 4.8 ± 3.4 hours after a positive Tn test. Mean age was 54.2 14.6 yrs. CCTA demonstrated complete absence of CAD in 41 patients (44%; 22 M, 19 F). CAD with less than 25% stenosis was observed in 25 patients (27%; 10 M, 15 F). CAD with 25-50% stenosis was observed in 9 patients (10%; 8 M, 1 F). CAD with greater than 50% stenosis was observed in 19 patients (20%; 15 M, 4 F). Patients with greater than 50% stenosis were significantly older than patients with no CAD (47.6 vs. 59.1 yrs, p = 0.0073).

CONCLUSION

CCTA can be successfully used to exclude CAD in a carefully selected subgroup of patients with positive troponin with low clinical suspicion for ACS. In our study 44% of these low risk patients had no CAD and a further 27% of patients had CAD with less than 25% stenosis.

CLINICAL RELEVANCE/APPLICATION

Current management guidelines direct patients with positive troponin toward invasive catheter angiography. CCTA is a non-invasive alternative to image coronary arteries when the clinical picture suggests ACS is unlikely.

SSE06-05 Prognostic Value of CT Pulmonary Angiography (CTPA) Parameters in Acute Pulmonary Embolism (APE)

Monday, Nov. 27 3:40PM - 3:50PM Room: N228

Participants
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Simone Vanni, MD, Florence, Italy (*Abstract Co-Author*) Nothing to Disclose
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Marco Bartolini, MD, Florence, Italy (*Abstract Co-Author*) Nothing to Disclose
Vittorio Miele, MD, Florence, Italy (*Presenter*) Nothing to Disclose

PURPOSE

To correlate CTPA parameters with prognostic stratification of patients with APE

METHOD AND MATERIALS

We retrospectively evaluated 140 outpatients with symptomatic APE diagnosed with CTPA. Death or clinical deterioration at 30 days were the primary endpoint. CTPA were evaluated by two blinded readers for: quantitative obstruction of pulmonary arteries (using Qanadli score), right ventricle diameter/left ventricle diameter ratio (RVD/LVD) and diameters of pulmonary trunk, superior

cava vein, azygos vein and coronary sinus. We applied a multiple logistic regression analysis of CTPA parameters, (using the following measures: >9 mm for coronaric sinus, >10 mm for azigos vein, > 1,1 for RVD/LVD) to evaluate the association with right ventricle disfunction (RVD), measured by echocardiogram, and primary outcome.

RESULTS

20/140 patients (14,3%) experienced death or clinical deterioration. We didn't analyze superior cava vein diameter due to high interobserver variability. Multiple logistic regression analysis demonstrated a significative correlation between RVD/LVD >1,1 (OR 6,1 CI 95%2.1-18.5) and RVD. No association, however, was found between RVD and azygos vein and coronaric sinus diameters. Coronaric sinus diameter >9 mm (O 11,6 CI95% 2,5-52,7) significantly correlates with primary outcome.

CONCLUSION

In APE, RVD/LVD is as good as echocardiogram in predicting RVD. Coronaric sinus diameter correlates with risk of short-term adverse events.

CLINICAL RELEVANCE/APPLICATION

CT angiography parameters is as good as ecocardiogram in predictong right ventricle deterioration anche strongly correlates with short time adverse events.

SSE06-06 Recent Trends in Use of Coronary CT Angiography and Radionuclide Myocardial Perfusion Imaging in Emergency Department Patients with Chest Pain

Monday, Nov. 27 3:50PM - 4:00PM Room: N228

Participants
David C. Levin, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
Laurence Parker, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Ethan J. Halpern, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Recent studies by Litt, Hoffmann, Goldstein, and others have shown that in patients presenting to Emergency Departments (EDs) with chest pain, using coronary CT angiography (CCTA) as the initial imaging test leads to shorter ED length of stay, shorter time to diagnosis, higher frequency of discharge from the ED, and lower costs, compared with standard therapy which commonly involves use of radionuclide myocardial perfusion imaging (MPI). There is no difference in outcomes. Our goal was to compare recent trends in use of these 2 imaging modalities in ED patients.

METHOD AND MATERIALS

We analyzed the nationwide Medicare Physician/Supplier Procedure Summary Master Files for 2006-2015. The CPT codes for CCTA and MPI were selected and procedure volumes were tabulated. Medicare's place-of-service codes were used to identify those exams done in EDs. Medicare's specialty codes were also used to determine the number of these exams done by radiologists and cardiologists.

RESULTS

In 2006, a total of 22,342 MPIs were done in Medicare ED patients. Except for a dip in 2010, volume remained relatively stable over the ensuing years and was virtually identical in 2015 (22,338) to its 2006 level. By comparison, in 2006 a total of 126 CCTAs were performed in Medicare ED patients. This number increased steadily in subsequent years and reached 1919 by 2015 (+1423%). The 2015 ratio of use of MPIs to CCTAs in EDs was 11.6 to 1. In 2015, radiologists interpreted 78% of ED MPIs and 83% of ED CCTAs. Cardiologists interpreted 21% of ED MPIs and 16% of ED CCTAs.

CONCLUSION

Volumes of MPIs done in ED patients with chest pain have remained relatively stable in recent years. CCTA volume has increased rapidly, but is still far below that of MPI. This is of concern in view of previous studies showing that CCTA is a more effective and efficient procedure in these ED patients. Radiologists appear to have a stronger presence than cardiologists in ED imaging of patients with suspected coronary artery disease.

CLINICAL RELEVANCE/APPLICATION

CCTA use is increasing rapidly in ED patients with chest pain, but it is still used much less frequently than MPI.

SSE07

Gastrointestinal (Image Biomarkers)

Monday, Nov. 27 3:00PM - 4:00PM Room: E350

BQ GI MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Michael S. Gee, MD, PhD, Jamaica Plain, MA (*Moderator*) Nothing to Disclose
Jason A. Pietryga, MD, Riverside, RI (*Moderator*) Nothing to Disclose

Sub-Events

SSE07-01 Baseline Tumor Enhancement and Apparent Diffusion Coefficient in Predicting Short-Term Response to TACE in Breast Metastases to the Liver: A Volumetric Technique

Monday, Nov. 27 3:00PM - 3:10PM Room: E350

Participants
Daniel Fadaei Fouladi, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
Manijeh Zarghampour, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Mounes Aliyari Ghasabeh, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Ankur Pandey, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Pegah Khoshpouri, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Farnaz Najmi Varzaneh, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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Nanna Shao, MBBS, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Ihab R. Kamel, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG

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PURPOSE

To investigate whether magnetic resonance (MR) obtained volumetric pretreatment enhancement and apparent diffusion coefficient (ADC) and their change after treatment may predict short-term response in patients with liver breast cancer metastases

METHOD AND MATERIALS

In this retrospective, HIPAA compliant study liver MR images of 91 patients with breast liver metastases (2004-2015) who had received hepatic trans-arterial chemoembolization (TACE) were reviewed. Baseline and 2-4 months post-TACE volumetric lesion enhancement in the portal venous phase (PVP) and ADC (b value >500) were calculated using a prototype Siemens Healthcare-developed software (MR Onco-Treat). Percent change in the largest transverse diameter at 2-4 month post-treatment was defined according to Response Evaluation Criteria in Solid Tumors (RECIST), and decrease in size by 30% was considered partial response to therapy. SPSS software (ver. 21) and Mann-Whitney U test were used for statistical analysis.

RESULTS

The median pretreatment ADC value was significantly lower in the group with partial response to treatment as compared to that with stable disease (1240.4 x 10-6 mm2/s vs. 1433.9 x 10-6 mm2/s, p=0.03). Post-TACE percent increase in ADC value and percent decrease in PVP enhancement were significantly more in patients with partial response to treatment compared to those with stable disease (28.5% vs. 0.9%, p<=0.04 and -25.5% vs. -5.0%, p<0.01, respectively). The two groups were comparable as to the baseline enhancement during the PVP (64.5% in those with partial response vs. 85.3% in those with stable disease, p=0.19).

CONCLUSION

Volumetric baseline ADC, as well as post-TACE enhancement and ADC changes were associated with response to treatment in patients with breast cancer metastases to the liver. Accordingly, a lower baseline ADC, more decrease in post-TACE enhancement during the PVP and more increase in post-TACE ADC were indicators of a better response to treatment.

CLINICAL RELEVANCE/APPLICATION

Baseline volumetric ADC could be used to predict prognosis in patients with breast cancer metastasis to the liver.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ihab R. Kamel, MD, PhD - 2015 Honored Educator

SSE07-02 Volumetric Functional MRI as New Prognostic Marker to Predict Survival in Unresectable Intrahepatic

Cholangiocarcinoma Undergoing Systemic Chemotherapy: Long Term Single Institution Outcomes

Monday, Nov. 27 3:10PM - 3:20PM Room: E350

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Value of multi-parametric assessment of volumetric functional MRI in predicting overall survival (OS) of patients with unresectable intrahepatic cholangiocarcinoma (iCCA) treated with systemic chemotherapy.

METHOD AND MATERIALS

72 patients (mean age 65±13 years, 29 males) with unresectable iCCA were included in this retrospective HIPAA compliant, IRB approved study with waived patient consent. All patients received systemic chemotherapy as the only treatment after undergoing baseline CE-MRI with DWI/ADC map. Single largest lesion was assessed using semi-automatic software for RECIST and volume, and volumetric functional parameters including viable tumor volume, percent viable tumor volume (100* viable tumor volume/whole tumor volume), percent viable tumor burden (100* viable tumor volume/whole liver volume), and ADC. These parameters were compared between low (<=10 months) and high (>10 months) OS groups. ROC, Cox regression and Kaplan Meier survival analysis was performed. P<0.05 was considered significant.

RESULTS

RECIST (58.9±40.4 vs 43.9±26.0 mm; P=0.06), tumor volume (142.2±232.4 vs 77.8±93.2 cm3, P=0.18), viable tumor volume (58.3±89.3 vs 55.1±67.2 cm3; P=0.887) and percent viable tumor burden (2.8±4% vs 2.8±3.0%; P=0.975) were not different between low and high OS groups. Baseline ADC was lower (1228.9±207.2 vs 1621.6±412.7 x 10-6 mm2/s; P<0.0001) and percent viable tumor volume was higher (58.5±37.7 vs 81.7±21.3%; P=0.009) in OS >10 months. Baseline ADC cut off 1325 x 10-6 mm2/s could differentiate low from high OS with a sensitivity, specificity and accuracy of 76.9%, 81.8% and 81.4%, respectively, with better OS for ADC <= 1325 x 10-6 mm2/s (log-rank test, P<0.001). Univariate Cox regression analysis revealed association of baseline ADC (HR, 1.003; P<0.0001) and percent viable tumor volume (HR, 0.981; P<0.01) with OS.

CONCLUSION

There is 0.3% increase and 1.9% decrease in the expected mortality risk relative to a unit increase in baseline ADC and percent viable tumor volume, respectively, in iCCA patients receiving systemic chemotherapy. ADC cut off of 1325 x 10-6 mm2/s at baseline showed OS differences with an accuracy of 81% in identifying patients with OS more than 10 months.

CLINICAL RELEVANCE/APPLICATION

Baseline functional MR parameters like volumetric ADC and percent viable tumor can be used to assess mortality risk and predict OS in patients with unresectable iCCA receiving systemic chemotherapy.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ihab R. Kamel, MD, PhD - 2015 Honored Educator

SSE07-03 Pre-Surgical Texture Analysis of Rectal Cancer to Distinguish Residual Tumor from Complete Response

Monday, Nov. 27 3:20PM - 3:30PM Room: E350

Participants
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PURPOSE

Non-operative management in patients with complete response is a new trend, but hinge on accurate imaging and clinical assessment. To investigate ability of texture features to differentiate residual tumor from complete response on rectal MRI.

METHOD AND MATERIALS

IRB approved retrospective study of 30 patients, with preoperative rectal MRI. Uniform pre-operative treatment included induction chemotherapy and neoadjuvant chemoradiation, followed by surgery. 3D volume of interest (VOI) was manually delineated from oblique axial T2 images using ITK-SNAP software. Haralick texture features (energy, entropy, correlation, contrast, homogeneity), and Gabor edge images at angles 0, 45, and 90 were computed from within delineated VOIs using in-house developed software. The features were tested for significance by comparing patients with complete vs. partial response on surgical pathology. Additionally, elastic net regression using Least absolute shrinkage and selection operator (LASSO) regression was performed to extract the most relevant features with alpha=0.1. Leave-one-out cross- validation (LOOCV) was performed to extract the best model.

RESULTS

21/30 cases were analyzed (6 excluded due to insufficient 3D coverage, and 3 due to mucin). Preliminary results showed that three texture features (entropy p=0.044, Gabor(0°) p=0.027, and Gabor(45°) p=0.04) showed statistically significant differences between partial and complete tumor response. Elastic net regression identified correlation, entropy, Gabor(0°) and Gabor(45°) to be relevant for distinguishing between complete and partial response. The feature weights were: correlation=0.0017, entropy=0.0027, Gabor(0°) = 0.007, and Gabor(45°) = 0.0037. The mean square error of the regression analysis was (RMSE=0.48). Figure shows post-treatment MRIs of 2 patients, the first with complete response and the second with partial. Table shows the application of texture analysis to MR images in these patients.

CONCLUSION

Combining texture features may predict partial from complete tumor response. Further studies with larger number of cases are important to confirm preliminary results.

CLINICAL RELEVANCE/APPLICATION

Preliminary results indicate that it is potentially feasible to use texture features to assess response. Our results suggest that lesions depicting lower heterogeneity in terms of edges and those depicting higher entropy are associated with complete response.

SSE07-04 Magnetic Resonance Tumor Regression Grade (mrTRG) To Assess Response after Neoadjuvant Chemoradiation Therapy for Locally Advanced Rectal Cancer: Pathologic Characteristics of the Response Assessment System

Monday, Nov. 27 3:30PM - 3:40PM Room: E350

Awards
Trainee Research Prize - Fellow

Participants
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PURPOSE

Chemoradiation therapy (CRT) before surgery has become the standard for locally advanced rectal cancer. Imaging methods to assess CRT response have been proposed, of which magnetic resonance tumor regression grade (mrTRG) is most prominent although its pathologic characteristics are not well known yet. This study is to determine the pathologic nature of mrTRG and suggest how to use mrTRG for patient management.

METHOD AND MATERIALS

472 consecutive patients (M:F, 308:164; 62.2±11.8 years) who had newly diagnosed rectal cancer of T3 or N+ stage as assessed with MRI, no distant metastasis or any lesions that were not cleared of metastasis as evaluated with both CT and PET/CT, and no previous (during past 5 years) or concomitant cancers, underwent long-course CRT. We finally analyzed 439 patients after excluding dropouts during CRT (n=19), no post-CRT MRI (n=4), no surgical resection (n=9), and loss of pathology data (n=1). Post-CRT MRI was obtained 4-6 weeks after the finish of CRT. Three experienced abdominal radiologists evaluated CRT response using mrTRG (1 to 5). Pathologic tumor regression was graded using surgical specimen according to complete (1), near complete (2), moderate (3), minimal (4), and no regression (5). We performed a correlative analysis between mrTRG and pathologic TRG and pT stage.

RESULTS

The study cohort consisted of pathologic TRG1 (n=88), 2 (n=113), 3 (n=175), 4 (n=62), and 5 (n=1). mrTRG grades distributed similarly, showing 15% mrTRG1 (n=66), 25.5% mrTRG2 (n=112), 37.1% mrTRG3 (n=163), 21.4% mrTRG4 (n=94), and 0.9% mrTRG5 (n=4). mrTRG1 showed complete and near complete regression in 60.6% and 27.3%, respectively. These were 22.3% and 52.7%, respectively, for mrTRG2. mrTRG3 and 4 had only 26.4% and 14.9%, respectively, rates of combined complete and near complete regression. Pathologic T stages of mrTRG1 were pT0 (ie, complete regression) in 60.6%, pT2 or lower in 89.4%, and pT3/4 without achieving near complete regression in only 3%. When mrTRG1 and 2 are combined, these values were 36.5%, 77.5%, and 7.9%.

CONCLUSION

mrTRG1, possibly combined mrTRG 1 and 2, seems to be reasonable criteria to recommend a local excision instead of a radical surgery while it seems unclear if mrTRG could be a robust tool to find candidates for nonsurgical observation.

CLINICAL RELEVANCE/APPLICATION

mrTRG could be used to guide local excision of rectal cancer after CRT, which should be further proved with oncologic outcome trials.

SSE07-05 Texture Analysis Can Be a Potential Tool to Differentiate Gastrointestinal Stromal Tumors with KIT Exon 11 Mutations, which is an Important Genotype for Imatinib Therapy, on Enhanced CT Images

Monday, Nov. 27 3:40PM - 3:50PM Room: E350

Participants
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PURPOSE

To determine the accuracy of texture analysis to differentiate gastrointestinal stromal tumors (GISTs) with KIT exon 11 mutations on enhanced CT images.

METHOD AND MATERIALS

Ethical approval was obtained for this retrospective analysis, and the requirement for informed consent was waived. This study consisted 69 patients with GISTs, of which 46 patients with KIT exon 11 mutations (yes-exon11-GISTs), and 23 patients without KIT exon 11 mutations (no-exon11-GISTs). Clinical information of the patients were collected and their correlation with GISTs genotypes were analyzed. Enhanced CT images including two sets of single-section were contoured manually by three independent radiologists. Two-dimensional texture analysis were performed for each lesion and the repeatability was assessed. Texture features including histogram parameters, Gray-Level Co-occurrence Matrix Parameters, and Gray-Level Run Length Matrix Parameters, were evaluated. Logistic regression models were built using clinical features and CT texture parameters. Enhanced CT images for each patient were independently reviewed by two radiologists who subjectively graded lesion heterogeneity on a five-point scale, and the correlation between the subjective heterogeneity rating and GISTs genotypes were evaluated.

RESULTS

There were lower lesion heterogeneity in yes-exon11-GISTs. The repeatability of the texture features were very good within and between readers. The texture parameters stdDeviation was included in the logistic regression model in each ROI session. The AUCs of stdDeviation ranged from 0.727±0.063 to 0.750±0.063. The visual subjective heterogeneity rating evaluated by the two radiologists had no significant difference between yes-exon11-GISTs and no-exon11-GISTs.

CONCLUSION

CT texture analysis can be used to differentiate GISTs with exon 11 mutations in KIT gene from those GISTs without KIT exon 11 mutations on enhanced CT images.

CLINICAL RELEVANCE/APPLICATION

The specific mutation in GISTs correlates with clinical response to molecular therapies. The importance of matching the GISTs genotypes with specific therapies, which makes precision medicine for GISTs feasible, have been noticed. Patients with exon 11 mutations of KIT gene are more likely to respond to imatinib than those with other mutations or those who are wild type for KIT and PDGFRA mutations. Our study suggest that CT texture analysis can be used to differentiate yes-exon11-GISTS from no-exon11-GISTs.

SSE07-06 Using Texture Analysis on Perfusion-Weighted Magnetic Resonance Imaging in Assessing Microvascular Invasion of Hepatocellular Carcinoma

Monday, Nov. 27 3:50PM - 4:00PM Room: E350

Participants
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PURPOSE

To prospectively test whether the texture analysis on perfusion-weighted magnetic resonance imaging (PW-MRI) can offer reliable indexes capable of predicting and grading microvascular invasion (MVI) of hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

Perfusion-weighted magnetic resonance imaging was performed on 31 HCC patients on a 3.0 Tesla MR scanner. The perfusion data was acquired using a prototype radial stack-of-stars three-dimensional spoiled gradient echo pulse sequence with golden-angle radial sampling schemes over the course of 6.25 minutes. Post-processing of PW-MRI data was performed on an in-housed software O.K.(Omini-Kinetics) to calculate Ktrans, Kep, Ve and the semi-quantitative parameter of area under the curve (AUC) using the Extended Tofts linear model, followed by texture analysis on those parametric maps using the same software. A total of 75 texture features were calculated for each perfusion results. The presence of MVI was histopathologically determined and classified into three groups: A-negative (without MVI), B-mild (had one to five invaded vessels), and C-severe (had more than five invaded vessels). Spearman correlation coefficients were determined between texture parameters and the degree of MVI. Receiver operation characteristic (ROC) analysis of predicting the presence of MVI was performed for identified texture parameters.

RESULTS

The MinLocation of Ktrans (r=0.377, P=0.037), RelativeDeviation of Ve (r=0.371, P=0.04) as well as the MinIntensity (r=-0.366, P=0.043), MinLocation (r=0.377, P=0.037), skewness (r=0.542, P=0.002) and kurtosis (r=0.467, P=0.008) of AUC mapping showed week to moderate correlations with the degree of MVI. The MinLocation, skewness and kurtosis of AUC were significantly different between the groups with and without MVI (P<0.05), with area under the ROC curve of 0.707, 0.859 and 0.734, respectively, in predicting the presence of MVI.

CONCLUSION

A combination of perfusion-weighted magnetic resonance imaging and texture analysis can help predicting and grading microvascular invasion (MVI) of hepatocellular carcinoma (HCC))

CLINICAL RELEVANCE/APPLICATION

Texture analysis on PW-MRI provides additional information regarding distribution and heterogeneity of intratumoral microvasculature, and therefore helps non-invasive evaluation of tumor MVI.

RSNA 2017 Explore. Invent. Transform.
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November 26 to December 1
McCormick Place, Chicago
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SSE08

Gastrointestinal (Elastography)

Monday, Nov. 27 3:00PM - 4:00PM Room: E352

GI MR US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSE08-01 Hepatic MR Elastography at 3T: Agreement Across Pulse Sequences and Effect of Hepatic Iron

Monday, Nov. 27 3:00PM - 3:10PM Room: E352

Participants
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PURPOSE

To compare 3 prototype hepatic magnetic resonance elastography (MRE) sequences at 3T with the standard clinical implementation gradient echo (GRE) sequence and to determine the effect of hepatic R2* on measurable area of liver stiffness (LS).

METHOD AND MATERIALS

52 patients (28 men, 24 women; mean age 56 years) underwent liver MRE at 3T (MAGNETOM Prisma, Siemens Healthcare) in this IRB-approved, HIPAA-compliant study. Sequences included: GRE (TR/TE 50/22 msec; slice thickness/gap 5/1 mm; matrix 77 x128; phase partial Fourier; flip angle, 250; breath hold, 18 sec), rapid GRE (TR/TE 25/22 msec; slice thickness/gap 5/1 mm; matrix, 84 x 128; flip angle, 150, breath hold, 9 sec), rapid fractional GRE (TR/TE 25/15 msec; slice thickness/gap 5/1 mm; matrix, 84 x 128; flip angle, 150, breath hold, 9 sec), and spin-echo echoplanar imaging (SE-EPI) (TR/TE 1600/49; slice thickness/gap 5/1 mm; matrix, 128 x 128; echo train length, 47; flip angle, 900; breath hold 18 sec). Hepatic R2* values were calculated using a multi-echo Dixon technique (LiverLab, Siemens). Mean LS and measurable area of stiffness (> 95% confidence threshold) were compared. Hepatic R2* was correlated with measurable area of LS and technical success rate.

RESULTS

In 6/52 patients, $\geq$ 1 sequence (5 GRE, 1 GRE and SE-EPI) failed (< 100 mm2 measurable area of LS). Mean LS was not significantly different across the 4 sequences (GRE 2.55 kPa, Rapid GRE 2.66 kPa, Rapid Fractional GRE 2.51 kPa, SE-EPI 2.52 kPa; P = 0.10). There was a significant difference in measurable area of LS (GRE 12389 mm2, Rapid GRE 14053 mm2, Rapid Fractional GRE 17039 mm2, SE-EPI 11212 mm2, P < 0.0001). Hepatic R2* was inversely correlated with measurable LS area for all 4 sequences (P < 0.0004). Mean hepatic R2* was higher among patients in whom $\geq$ 1 pulse sequence failed (mean R2* 100 sec-1 vs 50 sec-1, P = 0.0065).

CONCLUSION

Measured LS was equivalent across 4 hepatic MRE sequences, but there was a significant difference in measurable area of LS, with the largest area achieved with the rapid fractional GRE sequence. Hepatic R2* was significantly correlated with measurable area of LS and was significantly higher among patients with one or more failed sequences.

CLINICAL RELEVANCE/APPLICATION

Modified GRE (reduced TR/TE) or SE-EPI sequences may be useful alternatives for hepatic MRE, especially at 3T, because of less susceptibility to T2* effects associated with liver iron and shorter breath-holds.

SSE08-02 Evaluation of Hepatic Fibrosis by Using Monoexponential, Biexponential, and Stretched Exponential Diffusion-Weighted MR Imaging

Monday, Nov. 27 3:10PM - 3:20PM Room: E352

Participants
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PURPOSE

To compare the ability of diffusion parameters acquired from monoexponential, biexponential, and stretched exponential diffusion-weighted imaging (DWI) models for the diagnosis of hepatic fibrosis (HF)

METHOD AND MATERIALS

Ninety five patients who underwent DWI using 9 b-values at 3T and had a pathologic reference standard of HF were included in this study. Liver apparent diffusion coefficient (ADC) obtained from a monoexponential model; true diffusion coefficient (Dt), pseudo-diffusion coefficient (Dp), and perfusion fraction (f) calculated from a biexponential model; distributed diffusion coefficient (DDC) and diffusion heterogeneity index (a) obtained from a stretched exponential model were compared with the pathologic HF stage (F). For the stretched exponential model, parameters were also obtained using a 6 b-value dataset with omitted lower b values (DDC#, a#). Spearman correlation analysis was performed to assess the relationship between HF and DWI parameters. The accuracy of DWI in the determination of HF stage was evaluated with Obuchowski measures. Diagnostic performance in diagnosing significant HF (>= F2) was compared using generalized estimating equation.

RESULTS

All parameters except Dt showed a significant negative correlation with the HF stage ($P < 0.05$). Among these, DDC# showed the strongest negative correlation with the HF stage ($\rho = -0.61$). The diagnostic accuracy for HF staging was highest for DDC# (Obuchowski measures, 0.770 ± 0.03) followed by a# (0.768 ± 0.04), DDC (0.748 ± 0.03), and Dp (0.728 ± 0.04). The accuracy of DDC# (78.9%) for determining significant HF (>= F2) was significantly higher than that of ADC, Dt, and f ($P < 0.05$). Dp showed similar accuracy (74.7%) with DDC# for determining >= F2 ($P > 0.999$), but revealed significantly lower specificity than DDC# (61.4% vs. 93.2%, $P < 0.001$). The diagnostic performance of DDC and a obtained with all b-values were not significantly different from those with 6 b-values (DDC#, a#) ($P > 0.05$).

CONCLUSION

Stretched exponential DWI is a promising method in the staging of HF. DDC showed comparable or better diagnostic performance with Dp even at fewer b-value acquisition.

CLINICAL RELEVANCE/APPLICATION

Stretched exponential DWI is a promising noninvasive method for classifying the severity of hepatic fibrosis, and it has the advantage of reducing scanning time with fewer b-value acquisitions.

SSE08-03 Evaluation of 2-D Ultrasound Shear Wave Elastography, Magnetic Resonance Elastography and Transient Elastography for the Non-Invasive Diagnosis of Advanced Fibrosis in Patients with Nonalcoholic Fatty Liver Disease: Preliminary Results

Monday, Nov. 27 3:20PM - 3:30PM Room: E352

Participants
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PURPOSE

To evaluate the performance of 2D ultrasound shear wave elastrography (2D-SWE), magnetic resonance elastography (MRE) and transient elastography (TE) for the diagnosis of advanced fibrosis in patients with biopsy-proven nonalcoholic fatty liver disease (NAFLD).

METHOD AND MATERIALS

In this IRB-approved, cross-sectional study 35 (21F, 14M) adult subjects (mean age, 50 years) with biopsy-proven NAFLD were prospectively recruited. The patients underwent 2D-SWE, MRE and TE the same day and with a median interval time of 72 days from liver biopsy. 2D-SWE was performed on a GE LOGIQ E9 scanner. MRE was conducted on a 1.5T scanner using a 2D-GRE sequence (GE Healthcare). TE was performed on Fibroscan (Echosens) using the XL probe. The median of measurements in the right hepatic lobe was considered for statistical analysis. Histologic evaluation included the fibrosis stage (F0-4) and the NAFLD activity score (NAS). Receiver operating characteristic (ROC) analysis was used to evaluate the performances of 2D-SWE, MRE and TE in diagnosing advanced fibrosis (F3-F4). Logistic regression analysis was used to assess the effect of BMI and NAS score on the diagnostic performance.

RESULTS

The distribution of fibrosis stage was as follow: F1, n=10; F2, n=13; F3, n=6; F4, n=4. 2D-SWE, MRE and TE detected advanced fibrosis with an area under the ROC (AUROC) respectively of 0.85 (95% confidence interval [CI], 0.72-0.97; P=0.001), 0.95 (95%

CI, 0.88-1.0; P<0.001) and 0.94 (95% CI, 0.86-1.0; P<0.001). The mean ± SD BMI was 34.5 ± 7.3 kg/m2 and the mean ± SD NAS was 4.7±1.4. NAS was significantly associated with changes in AUROC (Odds ratio=3.1; P=0.012).

CONCLUSION

2D-SWE, MRE and TE are highly accurate methods for the non-invasive diagnosis of advanced fibrosis in patients with NAFLD.

CLINICAL RELEVANCE/APPLICATION

Ultrasound and MR-based elastography methods are highly accurate for the detection of advanced fibrosis in patients with NAFLD.

SSE08-04 Correlation of Liver Stiffness Values Measured by Transient Elastography with Histopathologic Grading of Hepatic Fibrosis by Quantitative Morphometric Measurement and Semi-Quantitative Analysis

Monday, Nov. 27 3:30PM - 3:40PM Room: E352

Participants
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PURPOSE

To correlate liver stiffness values measured by transient elastography with two different histopathologic fibrosis grading systems, i.e. quantitative morphometric measurement of the fibrosis area and semi-quantitative analyses using the METAVIR score

METHOD AND MATERIALS

This prospective study was approved by the institutional review board and informed consent was obtained. We finally enrolled 74 subjects who were examined by transient elastography and underwent liver resection for focal hepatic lesions (60 subjects) or donor lobectomy (14 subjects) from March 2015 to January 2016. The time interval between transient elastography and liver resection was less than one month. Histopathologic hepatic fibrosis was graded quantitatively by using morphometry of the fibrosis area and semi-quantitatively by using the METAVIR score. The Spearman correlation coefficient (ρ) was used to examine the correlation between liver stiffness values measured by transient elastography and the two histopathologic fibrosis grading systems. The correlation between the two histopathologic fibrosis grading systems was also analyzed.

RESULTS

Liver stiffness values measured by transient elastography were poorly correlated with quantitiative morphologic analysis of the fibrosis area ($\rho = 0.305$, $P = 0.008$), while they were much better correlated with the METAVIR score ($\rho = 0.729$, $P < 0.001$). The correlation between the two histopathologic fibrosis grading systems was also poor and not significant ($r = 0.265$, $P = 0.265$).

CONCLUSION

Liver stiffness values measured by transient elastography were correlated better with semi-quantitative histopathologic grading than with qualitative morphometric analyses.

CLINICAL RELEVANCE/APPLICATION

This study enhances our understanding of physical properties measured by US elastography on the basis of histopathologic backgrounds.

SSE08-05 Two-Center Experience with Ultrasound Elastography in Cirrhosis: Factors Affecting the Application of SRU Consensus Guidelines

Monday, Nov. 27 3:40PM - 3:50PM Room: E352

Participants
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PURPOSE

1) To evaluate if patients with known hepatic cirrhosis have shear wave velocities of >2.2 m/s, the cutoff for advanced fibrosis established by recent SRU guidelines.2) To identify potential patient or technique-related factors that can lower the otherwise expected high stiffness measurements in patients with cirrhosis.

METHOD AND MATERIALS

In this IRB-approved study, we identified 131 patients with known cirrhosis from two large academic centers. Thirty of these patients did not qualify due to lack of sufficient criteria for cirrhosis, 17 were excluded due to high interquartile range/median value

(>0.3), and 2 were considered invalid due to unexpectedly high numbers (>5 m/s). All of the remaining 82 patients underwent Acoustic Radiation Forced Impulse (ARFI) Shear Wave Elastography (SWE) using a Philips EPIQ ultrasound machine. Ten shear wave velocity (SWV) measurements were obtained and the median was considered the final SWV.

RESULTS

Patient age ranged from 28-79 years (mean 58). SWV ranged from 1.17-2.66 m/s. Only 9 (11%) patients met the SRU cutoff of SWV > 2.2 m/s for advanced fibrosis, and 9 (11%) patients demonstrated normal SWV (<1.34 m/s). There was weak correlation (0.3-0.5) between SWV and elevated liver function tests (LFTs) as well as lower platelet counts. However, there was no correlation between SWV and HCV titers, serum fibrosis/inflammation tests, body-mass-index, age, and presence of portal hypertension. All patients with sustained viral response (SVR) and/or Harvoni treatment had SWV <1.8 m/s, but there was no significant difference in SWV between patients with and without SVR.

CONCLUSION

The vast majority (89%) of patients with cirrhosis demonstrate SWV less than the SRU cutoff of 2.2 m/s. Only weak correlation was noted between SWV and LFTs as well as low platelet counts. No other factors demonstrated a significant effect on SWV alone, indicating a multifactorial approach may be more appropriate. Our study suggests that revision of the current SRU cutoff may be necessary in the near future.

CLINICAL RELEVANCE/APPLICATION

The current SRU cutoff of SWV > 2.2 m/s would miss the majority of patients with advanced fibrosis (including cirrhosis) and thus revision of these guidelines may be necessary in the near future.

SSE08-06 Hepatic Sinusoidal Obstruction Syndrome: Diagnostic Value of Ultrasound Shear-Wave Elastography - An Experimental Study in a Rat Model

Monday, Nov. 27 3:50PM - 4:00PM Room: E352

Participants
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PURPOSE

To evaluate the diagnostic value of ultrasound shear-wave elastography (SWE) in the assessment of hepatic sinusoidal obstruction syndrome (SOS) in a monocrotaline (MCT)-induced rat SOS model.

METHOD AND MATERIALS

The institutional animal care and use committee approved this study. Twenty rats were randomly divided into four groups with five animals each. Each group of animals were administered phosphate-buffered saline vehicle, or different doses of MCT (90, 160, and 200 mg/kg) by gavage. All rats underwent liver stiffness measurement (LSM) by 2D ultrasound SWE and immediately sacrificed to obtain liver tissue. LSMs were correlated with histologic grades of SOS using Spearman's rank correlation test, and receiver operating characteristic (ROC) curve analysis was performed to determine the accuracy and cutoff values for SOS severity.

RESULTS

According to histologic analysis, 10, 4, and 6 rats were categorized as having none, mild, and moderate/severe SOS, respectively. LSM by ultrasound SWE showed significant correlation with SOS severity (rho = 0.91, P <0.001) with means of 6.2, 10.5, and 12.3 kPa, in none, mild, and moderate/severe SOS, respectively. The area under the ROC curves were 0.98 (none vs. mild or moderate/severe) and 0.93 (none or mild vs. moderate/severe) with optimal cutoffs of LSM of 7.9 and 8.5 kPa, respectively.

CONCLUSION

LSM by ultrasound SWE may be helpful in the diagnosis and severity classification of hepatic SOS.

CLINICAL RELEVANCE/APPLICATION

Hepatic sinusoidal obstruction syndrome (SOS), a drug-induced liver injury, is associated with increased morbidity after major hepatectomy. Therefore, there has been a great need of a noninvasive quantitative test for diagnosis and monitoring of hepatic SOS. This animal study suggests that ultrasound shear wave elastography can be useful in the noninvasive assessment of hepatic SOS while further validation is needed in human subjects.

SSE09

Gastrointestinal (CT Dose)

Monday, Nov. 27 3:00PM - 4:00PM Room: E353B

CT GI SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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William P. Shuman, MD, Seattle, WA (*Moderator*) Research Grant, General Electric Company

Sub-Events

SSE09-01 Comparative Study on Optimal Noise Index and Iterative Reconstruction Algorithms According to Patient's Body Weight in Abdomen-Pelvis CT

Monday, Nov. 27 3:00PM - 3:10PM Room: E353B

Participants
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PURPOSE

To figure out optimal noise indices and iterative reconstruction algorithms corresponding to patient's body weight in abdomen-pelvis CT.

METHOD AND MATERIALS

450 patients (40-90kg) who underwent abdomen-pelvis CT with AEC based on three different noise indices (NI) were retrospectively analyzed. We set control group (NI:10.5) and experimental groups (NI:12.81 and 14.8). To find out the relation among body weight, radiation dose, and NI, the patients of each group were stratified into 10 groups according to their body weight (40-90kg, 5kg intervals, 15 patients/group). When assessing image quality, we additionally adapted 30% and 50% adaptive statistical iterative reconstruction (ASIR) algorithms on the CT images of experimental groups to compensate for image quality deterioration. The volume CT dose index (CTDIvol), dose length product (DLP), and quantitatively hepatic noise according to body weight compared with control were assessed using two-way analysis of variance and Bonferroni p-value adjustments.

RESULTS

All values of CTDIvol and DLP had significantly differences in all steps of NI and body weight ($P<0.05$). The higher NI was, the lower radiation dose was in all cases. Due to the slope change of dose-weight graph, patients were divided into three groups which were classified as thin (below 55kg), normal (from 55 to 80kg), and obese (above 80kg). Among three NI, 12.81 was appropriate to thin and normal group, on the other hand, 14.8 was effective to reduce radiation dose for obese group. Usage of 30% and 50% ASIR algorithms can reduce image noise efficiently. Quantitatively hepatic noise in thin group with 30% ASIR and in obese group with 50% ASIR were similar to that in normal with FBP ($P>0.05$).

CONCLUSION

Different noise indices on the basis of body weight should be taken into account in abdomen-pelvis CT. For compensating for low image quality, it is imperative to use iterative reconstruction algorithms.

CLINICAL RELEVANCE/APPLICATION

We recommend that if you want to give an optimal dose to patients, you have to set NI of 12.81 and 14.8 in accordance with body weight. It is beneficial to use 30% ASIR below 55kg and 50% ASIR above 80kg by providing appropriate image quality.

SSE09-02 Effect of Visceral Fat Volume on CTE Image Quality at Full and Reduced Radiation Exposure Using FBP and Iterative Reconstructions

Monday, Nov. 27 3:10PM - 3:20PM Room: E353B

Participants
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PURPOSE

To evaluate the effect of of visceral fat volume on subjective image quality in CT Enterography (CTE) at full and reduced radiation exposure images using standard FBP and iterative reconstructions

METHOD AND MATERIALS

IRB approved, HIPAA compliant, retrospective, single center, cohort study consisting of 74 patients:active terminal ileal(TI) Crohns disease (n=37) and normal (n=37). All patients had CTE on a dual-source CT (100% exposure using both tubes) with filtered back projection(FBP) reconstruction. Primary source (30% exposure) data was extracted and reconstructed with FBP & Sinogram-Affirmed Iterative Reconstruction(SAFIRE) version 3 (strength 3 & 4). Using a 4-point scale for image quality (non-diagnostic, suboptimal, diagnostic, optimal), 7 readers, randomized and blinded to the exposure and reconstruction method, subjectively evaluated image quality for assessment of active TI Crohns disease. Visceral fat volume was calculated from the full exposure image sets using semi-automated software. Pearson's correlation coefficient was used to characterize the linear relationship between the number of readers indicating poor image quality and visceral fat volume.

RESULTS

There was a statistically significant association between low visceral fat volume and the number of readers indicating poor image quality. In 47 patients with < 2000 cc visceral fat volume, the majority (>3) of readers scored poor image quality for 2% of full exposure FBP, 23% of reduced exposure FBP, 17% of SAFIRE 3 and 40% of SAFIRE 4 images. In 27 patients with >= 2000 cm3 visceral fat volume, the majority (3) of readers scored poor image quality for 0% of full exposure FBP, 7% of reduced exposure FBP, 0% for SAFIRE 3 and 4% for SAFIRE 4 images. Pearson correlation coefficient (95% CI); -0.3(-0.5,-0.08) for full-exposure FBP, -0.29(-0.49,-0.07) for reduced-exposure FBP, -0.29(-0.48,-0.06) for SAFIRE 3 and -0.47(-0.63,-0.27) for SAFIRE 4

CONCLUSION

Low visceral fat volume is statistically significantly associated with poor subjective image quality in full exposure FBP and reduced exposure FBP and SAFIRE (3 and 4) CTE studies.

CLINICAL RELEVANCE/APPLICATION

Negative association between low visceral fat volume and image quality should be considered when designing reduced exposure protocols for CTE.

SSE09-03 A New Iterative Reconstruction CT Technique of Forward Projected Model-based IR Solution (FIRST): Evaluation of Image Quality, Radiation Dose Reduction, and Reconstruction Time at Upper Abdominal CT using an Anthropomorphic Phantom Model

Monday, Nov. 27 3:20PM - 3:30PM Room: E353B

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PURPOSE

Iterative reconstruction (IR) techniques can be used to improve the quality of low-dose CT images. Recently, a full iterative reconstruction method, Forward projected model-based IR SoluTion (FIRST) has become available. The purpose of our study was to evaluate the radiation dose reduction, image quality, and reconstruction time of upper abdominal CT images using FIRST in comparison with those of AIDR 3D (adaptive iterative dose reduction 3D) and FBP (filtered back projection) by using an anthropomorphic phantom.

METHOD AND MATERIALS

An anthropomorphic phantom of upper abdomen was scanned with a 320-slice CT scanner (Aquilion ONE/GENESIS; Toshiba). Five different tube currents were employed at 120 kVp: 25, 50, 100, 150 and 200 mAs. Scans for 20-cm scan length were performed five times at each mAs setting and axial 5-mm thickness images were reconstructed with FIRST, AIDR 3D and FBP. The reconstruction time and dose length product (DLP) were recorded for each scan. Image noises were defined by standard deviation of CT number of the material simulating subcutaneous fat. Contrast to noise ratio (CNR) was calculated from the contrast between liver parenchyma and portal vein. As a qualitative analysis, the image quality was visually assessed on a four-point scale. Paired t-test and Wilcoxon rank-sum test with Bonferroni adjustment were used to compare the continuous values and scores, respectively.

RESULTS

In the same mAs setting, FIRST yielded 40 - 70% and 13 - 31% noise reduction and 62 - 231% and 11 - 44% CNR increase compared to FBP and AIDR 3D, respectively. FIRST showed 270-s longer reconstruction time compared to FBP and AIDR 3D. Mean image noise and CNR of FIRST at 25 mAs (42.1 mGy/cm) were 8.3HU and 3.8, which were comparable to those of FBP at 200 mAs (352.6 mGy/cm; 10.0 HU and 3.3) and AIDR 3D at 50 mAs (84.2 mGy/cm; 9.4 HU and 3.4). However, the mean visual scores of FIRST were not significantly different with FBP and AIDR 3D at each mAs setting (P>0.05).

CONCLUSION

FIRST suppressed image noise and increased CNR compared to FBP and AIDR 3D in upper abdominal CT images. The reconstruction time (270 seconds increase) was supposed to be acceptable for routine clinical practice.

CLINICAL RELEVANCE/APPLICATION

FIRST, which has clinically acceptable reconstruction time of 270 seconds for 20 cm scan, is a promising technique for upper abdominal CT in terms of the radiation dose and image quality.

SSE09-04 Abdominal CT: Comparison of Low-Dose Spectral CT with Adaptive Statistical Iterative Reconstruction (ASIR) and Routine-Dose Conventional CT with ASIR in Patients with High BMI Values

Monday, Nov. 27 3:30PM - 3:40PM Room: E353B

Participants
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PURPOSE

To compare the radiation dose, noise and image quality of abdominal low-dose CT in spectral imaging mode reconstructed with ASIR and routine-dose conventional CT reconstructed with ASIR in patients with high body mass index (BMI) values

METHOD AND MATERIALS

With institutional review board approval and informed consent, 81 patients with high BMI values (>=29kg/m2) underwent contrast-enhanced abdominal CT during arterial phase (AP) and portal venous phase (PVP) were prospectively included .In chronological order, 41 patients were assigned to the control group using tube voltage of 120 kVp and images reconstruction with 30% ASIR (group A1) and 50% ASIR (group A2). Based on the volume CT dose index (CTDI vol) in the control group (21.71mGy), the nearly half of the dose in spectral CT with GSI-22 mode (CTDI=10.76mGy) was selected in the study group (n=40). Monochromatic images (40 to 70keV) were reconstructed using 50% ASIR (group B) in the study group. Quantitative parameters (image noise and contrast-to-noise ratio [CNR]of the liver, pancreas, aorta and portal vein) and qualitative visual parameters were compared. Statistical analysis was performed with two sample t tests, one-way ANOVA or Kruskal-Wallis H tests

RESULTS

During the AP and PVP,at the energy level of 40 keV and 50 keV,the study group showed higher CT values than control group,group B showed higher or similar CNRs,higher image noise and lower overall image quality scores point than group A1 and A2.At the energy levelof 60 keV,the study group showed higher CT values than control group except the CT values of live in AP,group B showed higher or similar CNRs,slightly higher image noise than group A1 and A2,and lower overall image quality scores than group A2 but similar scores to group A1.At the energy level of 70 keV,the study group showed similar CT values to the control group except the CT values of live in AP,group B showed higher CNRs and similar image noise than group A1 and A2,higher overall image quality scores than groupA1 and similar scores to group A2.

CONCLUSION

Compared with routine-dose conventional CT with ASIR, abdominal low-dose spectral CT with ASIR maintain overall image quality from 60 to 70 keV, thereby permitting diagnostic abdominal examinations with lower (by 51%) radiation doses

CLINICAL RELEVANCE/APPLICATION

Low-dose spectral CT with ASIR can maintain overall image quality from 60 to 70 keV, thereby permitting diagnostic abdominal examinations.

SSE09-05 The Diagnostic Performance of Low-dose CT for Suspected Appendicitis in Pediatric and Adult Patients: A Systematic Review and Diagnostic Meta-Analysis

Monday, Nov. 27 3:40PM - 3:50PM Room: E353B

Participants
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PURPOSE

To evaluate the diagnostic performance of low-dose CT for suspected appendicitis and to investigate the diagnostic performance of low-dose CT and standard-dose CT for a head-to-head comparison.

METHOD AND MATERIALS

A systematic search of the MEDLINE and EMBASE databases was combed through until January 10th, 2017. Pooled summary estimates of sensitivity and specificity were calculated using hierarchical logistic regression modeling. Meta-regression was performed.

RESULTS

14 original articles including a total of 3,262 patients were included. For all studies using low-dose CT, the summary sensitivity was 96% (95% CI, 93%-98%) with a summary specificity of 94% (95% CI, 92%-95%). For the 11 studies providing a head-to-head comparison between low-dose CT and standard-dose CT, low-dose CT demonstrated a comparable summary sensitivity of 96% (95% CI, 91%-98%) and specificity of 94% (95% CI, 93%-96%) without any significant differences (p=.41). In meta-regression, there were no significant factors affecting the heterogeneity. The median effective radiation dose of the low-dose CT was 1.8mSv (1.46-4.16mSv), which was a 78% reduction in effective radiation dose compared to the standard-dose CT.

CONCLUSION

Low-dose CT shows excellent diagnostic performance for suspected appendicitis. Low-dose CT has a comparable diagnostic performance with a 78% dose reduction compared to standard-dose CT.

CLINICAL RELEVANCE/APPLICATION

Low-dose CT has a comparable diagnostic performance with a 78% dose reduction for evaluating suspected appendicitis compared to standard-dose CT.

SSE09-06 Comparison of Two Commercial Adaptive Statistical Iterative Reconstruction (ASiR, ASiR-V) on Routine Liver CT: Objective and Subjective Image Quality Evaluation

Monday, Nov. 27 3:50PM - 4:00PM Room: E353B

Participants
Ning Pan, Xian, China (*Presenter*) Nothing to Disclose
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PURPOSE

To compare image quality for routine liver CT reconstructed with adaptive statistical iterative reconstruction (ASiR) and ASIR-V.

METHOD AND MATERIALS

This IRB-approved study included 46 patients clinically suspected hepatic metastases. Patients were divided equally into ASiR group (GE HD750 CT) and ASiR-V group (GE Revolution CT). Scan parameters were the same on both systems (120 kVp, auto mA for Noise Index of 12HU, detector collimation 0.625*64mm). Images were reconstructed with ASiR and ASiR-V from 0%-100% at 10% interval. Mean and standard deviation of CT numbers within regions of interest placed on 3 locations at the level of the right portal vein (erector muscle of spine, anterior abdominal fat and liver parenchyma) was recorded, and SNR was calculated. Two experienced radiologists independently graded image noise, visual sharpness of liver boundary, conspicuity of the hepatic veins within liver, visualization of the extrahepatic duct and diagnostic acceptability, using a 1-5 grading score. Statistical analysis was performed using Mann-Whitney U test for subjective image quality assessment.

RESULTS

The average effective dose of ASiR and ASiR-V group were 3.15±6.2mSv and 3.01±562mSv respectively with no difference. Objectively, Compared with FBP, as the percentage of ASiR and ASiR-V increased from 10% to 100%, image noise reduced by 8.6% to 57.9% and 8.9% to 81.6% respectively, and the SNR increased accordingly. For subjective evaluation, substantial inter-observer agreement was obtained for determination of image quality for reconstruction with ASiR as well as with ASiR-V. Compared with FBP reconstruction, subjective image quality score of ASiR and ASiR-V groups improved significantly as percentage increased from 10% to 70% for ASIR (42% noise reduction compared with FBP) and 60% (52% noise reduction compared with FBP) for ASIR-V, and declined afterwards due to waxy artifacts.

CONCLUSION

ASiR-V algorithm considerably improved objective and subjective image quality of routine liver CT images compared with those of FBP or ASiR. ASiR-V60% was the most appropriate strength for keeping a best balance between the noise and waxy artifacts of routine liver images in Revolution CT.

CLINICAL RELEVANCE/APPLICATION

Selecting a appropriate strength of ASiR-V algorithm can improve image quality in routine liver CT scanning.

SSE10

Science Session with Keynote: Gastrointestinal (Contrast Enhanced Ultrasound)

Monday, Nov. 27 3:00PM - 4:00PM Room: E353C

GI US BQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Aya Kamaya, MD, Stanford, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSE10-01 Gastrointestinal Keynote Speaker: Update on Contrast Enhanced Ultrasound (CEUS)

Monday, Nov. 27 3:00PM - 3:10PM Room: E353C

Participants
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SSE10-02 Preoperative and Intraoperative Contrast-Enhanced Ultrasound (CEUS/IOCEUS) of Liver Tumors in Comparison to Magnetic Resonance Imaging and Histopathology

Monday, Nov. 27 3:10PM - 3:20PM Room: E353C

Participants
Ernst Michael Jung, MD, Regensburg, Germany (*Presenter*) Speaker, Bracco Group
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PURPOSE

To evaluate the diagnostic significance of preoperatively and intraoperatively performed contrast-enhanced ultrasound (CEUS/IOCEUS) in the diagnosis of liver tumors, in comparison to magnetic resonance imaging (MRI) and histopathology.

METHOD AND MATERIALS

Findings of CEUS and IOCEUS were compared to MRI findings in 70 cases. CEUS and IOCEUS were performed using multifrequency linear probes (1-5, 6-15 MHz) after bolus injection of 1-5 ml sulphur hexaflouride microbubbles. Evaluation of histopathology after surgical resection, of MRI morphology (T1, T2, VIBE, Diffusion sequences) and wash-in/wash-out-kinetics of CEUS.

RESULTS

In 70 analyzed patient cases 64 malignant liver lesions could be detected 6 patients had benign liver lesions. Among the 64 malignant lesions there were 28 metastases, 24 hepatocellular carcinomas (HCC), 9 cholangiocellular carcinomas (CCC) and 3 gallbladder carcinomas. There was no significant difference when determining the lesion's malignancy/ benignity (p=1,000). Furthermore, there was no statistical significance between preoperative CEUS and MRI regarding the general differential diagnosis of a tumor (p=0,210) and the differential diagnosis classification between HCCs (p=0,453) and metastases (p=0,250).There was no statistical significance in tumor size (10 mm - 151 mm; Mean 49 mm SD +/- 31 mm) and localization (tumor size p=0,579; allocation to liver lobes p=0,132; segment diagnosis p=0,121) between preoperatively performed CEUS and MRI. IOCEUS offered the substantial advantage of locating additional liver lesions (p=0,004 compared to preoperative MRI, p=0,002 compared to preoperative CEUS). In 10/37 cases (27%) IOCEUS could locate further liver lesions which had not been recognized during CEUS and/or MRI preoperatively, so that operative therapy was adapted accordingly and resection was extended if necessary.

CONCLUSION

During liver operations CEUS plays an important role in surgical therapy decisions.

CLINICAL RELEVANCE/APPLICATION

After FDA permission very important indication for CEUS

SSE10-03 Hepatic Artery Obstruction after Liver Transplantation: Diagnostic Performance of CT Angiography and Contrast-Enhanced US

Monday, Nov. 27 3:20PM - 3:30PM Room: E353C

Participants
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PURPOSE

To evaluate diagnostic performance of computed tomographic angiography (CTA) and contrast-enhanced US (CEUS) to diagnose significant hepatic artery obstruction (HAO) in liver transplantation (LT) recipients suspected of HAO by Doppler US.

METHOD AND MATERIALS

The institutional review board approved this study, with a waiver of informed consent. Among 1246 adult LTs with 1320 grafts performed in a single institution from Jan 2014 to Feb 2017, 132 grafts in 130 recipients were suspected of HAO by Doppler US (no flow detection or pulsus parvus pattern). Of these, reference diagnosis of HAO was made by surgery (artery revision or retransplantation), hepatic arteriography, or by associated cross-sectional CT abnormality. We excluded 21 grafts in which neither CTA nor CEUS was obtained within 24 hours of reference diagnosis and the other 111 grafts with CTA (n=91), CEUS (n=68), or both (n=48) within 24 hours of the diagnosis were finally included. CTA and CEUS were retrospectively reviewed and the diagnostic performance of CTA and CEUS was assessed. Diagnostic accuracies of CTA and CEUS were compared using McNemar test in grafts evaluated with both modalities.

RESULTS

Incidence of significant HAO was 1.7% (23/1320). Most significant HAOs were found within 2 weeks after LT (mean, 8.7 days). The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of CTA were 92.9% (26/28), 91.0% (59/63), 86.7% (26/30), 96.7% (59/61), and 93.4% (85/91), respectively. Those of CEUS were 94.7% (18/19), 93.9% (46/49), 85.7% (18/21), 97.9% (46/47), and 94.1% (64/68), respectively. The accuracies of the two modalities were not significantly different ($p = 0.68$). CTA found one HAO that were missed by CEUS, and CEUS found two HAOs that were missed by CTA, vice versa. All false positive cases (n=4) of CTA were stenosis more than 50 % without significant flow disturbance. Two of three false positive cases of CEUS were dual grafts with poor sonic window.

CONCLUSION

Both CEUS and CTA are helpful and complementary tool for diagnosis of significant HAO in recipients with suspected HAO with Doppler US. CEUS was more accurate than CTA, but there was no statistical significance.

CLINICAL RELEVANCE/APPLICATION

Both CEUS and CT are helpful and complementary tool for evaluation of significant hepatic artery obstruction in recipients with suspected hepatic artery abnormality with Doppler US.

SSE10-04 Quantitative Ultrasound Spectroscopy to Differentiate Between Hepatocellular Carcinoma and At-Risk Liver Parenchyma

Monday, Nov. 27 3:30PM - 3:40PM Room: E353C

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PURPOSE

Ultrasound is the first-line imaging technology for HCC screening in high risk patients; however, it has limited sensitivity and specificity, in particular in patients with liver cirrhosis. Quantitative ultrasound spectroscopy (QUS) is an emerging technology that allows differentiation of tissue microstructures by analyzing the radiofrequency (RF) signals backscattered from biological tissues. QUS is independent of operator or instrumental settings by normalizing ultrasound signals against a reference. The aim of this study was to clinically assess QUS parameters in HCC compared to cirrhotic and non-cirrhotic at risk liver parenchyma.

METHOD AND MATERIALS

This prospective HIPAA-compliant study was approved by the IRB. Fifteen patients with liver cirrhosis and HCC and 15 non-HCC patients with chronic liver disease (7 chronic hepatitis B; 7 chronic hepatitis C; 1 cryptogenic cirrhosis) were included. Ultrasound RF data were obtained from each of the eight liver segments as well as from all HCC lesions by using an Ultrasonix Tablet at 2 center frequencies (3.3 and 5 MHz) and at 4 focal depths (3, 6, 9 and 12 cm). Regions-of-interest (ROI) were drawn and the three quantitative spectral parameters including mid-band fit (MBF), spectral intercept (SI), and spectral slope (SS) were extracted. Differences in QUS parameters were tested by a mixed-effects regression on ROI location.

RESULTS

There was a significant intra-individual difference in MBF and SI values between HCC and cirrhotic liver parenchyma (p<0.001), as well as a significant inter-individual difference between HCC lesions and the liver parenchyma in at-risk non-HCC liver parenchyma (p<0.001) (Figure). No statistical significance was noted between any of the parameters obtained in liver cirrhosis vs. non-cirrhotic at-risk liver parenchyma. No statistical significance was noted for the SS parameter between any of the groups.

CONCLUSION

The two QUS parameters MBF and SI are significantly different in HCC vs. non-HCC liver parenchyma and could be used for improved HCC detection.

CLINICAL RELEVANCE/APPLICATION

QUS is a complementary technology that can be further developed for improving screening results of ultrasound in patients at increased risk for HCC.

SSE10-05 Diagnostic Performance of 2015 American Thyroid Association Consensus Guidelines, 2005 Society of Radiologists in Ultrasound Consensus Guidelines and a Morphologic-based Likert Scale for Thyroid Cancer Detection after Ultrasound Guided FNA

Monday, Nov. 27 3:40PM - 3:50PM Room: E353C

Participants
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PURPOSE

To evaluate the performance of 2015 American Thyroid Association (ATA) Consensus Guidelines, 2005 Society of Radiologists in Ultrasound (SRU) Consensus Guidelines, and a morphology-based Likert scale for detecting thyroid cancer after fine needle aspiration (FNA) of thyroid nodules.

METHOD AND MATERIALS

A HIPAA-compliant, IRB-approved prospective study of 986 patients who underwent FNA from July 2014 to June 2016 was performed. Clinical, imaging, and pathology information were extracted from the medical records. The diagnostic performance of ATA, SRU and a morphologic-based Likert scale for predicting malignancy were assessed. Area under the receiver operating characteristic curve values for each of the reference guidelines and each interpreter were determined and subsequently compared.

RESULTS

986 patients with 1170 nodules were evaluated. The nondiagnostic rate was 63/1170 (5.4%). The malignancy rate was 162/1170 (13.8%). Papillary thyroid cancer made up 160/162 (71.6%) of the thyroid malignancies. Non-diagnostic FNAs (63/1170, 5.4%) were excluded, and the remaining 1107 nodules were analyzed. 691/1107 (62.4%) of nodules met 2005 SRU criteria for FNA. Of those, 90/691 (13.0%) were malignant on FNA. 686/1107 (62.0 %) of nodules met 2015 ATA criteria for FNA. Of those, 108/686 (15.8%) were malignant. 435/1170 (39%) of nodules reached suspicion levels of 3-5 on a 5 point morphologic based Likert scale. Of those 121/435 (27.8%) were malignant. The AUC for predicting malignancy for the morphologic-based Likert scale was 0.76; for ATA 0.68; and for SRU 0.57.

CONCLUSION

A morphologic-based Likert Scale performed better than 2015 ATA Consensus Guidelines, which performed better than the 2005 SRU Consensus Guidelines in predicting thyroid cancer on FNA.

CLINICAL RELEVANCE/APPLICATION

Our study supports the importance of morphologic-based criteria in predicting thyroid malignancy and the need for inter-societal consensus and guidelines, so that primary care physicians, radiologists, endocrinologists and endocrine surgeons can follow standardized lexicon and recommendations.

SSE10-06 Utility of Contrast Enhanced Ultrasound (CEUS) in the Evaluation of Postoperative Recurrence of Crohn's Disease

Monday, Nov. 27 3:50PM - 4:00PM Room: E353C

Participants
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PURPOSE

To assess the diagnostic accuracy of contrast enhanced ultrasound (CEUS) in the detection of endoscopic postsurgical recurrence of Crohn´s disease (CD) and its severity compared with ileocolonoscopy.

METHOD AND MATERIALS

A prospective study of 108 patients with CD who had undergone ileocolonic resection was performed. Several sonographic parameters were analyzed: neoterminal ileum wall thickness, transmural complications, color Doppler grade and contrast mural enhancement. Colonoscopy results were evaluated according the Rutgeerts score. The ability of ultrasound (US) and CEUS to diagnose endoscopic recurrence, as well as its severity, was assessed by calculating the sensitivity, specificity and positive and negative predictive values, accuracy and odds ratio. In addition a sonographic scale of severity was designed, including our best cutoff and data described in the literature. This scale and the combination of parameters were compared with endoscopic findings of severity.

RESULTS

Recurrence was detected in 90 cases (83%), and severe recurrence was present in 57% of them. The best parameters for the diagnosis of postsurgical endoscopic recurrence were: a) wall thickness >= 3 mm, with sensitivity 94%, specificity 72% and accuracy 91%, with good agreement with the colonoscopy (k = 0.66) and b) the combination of wall thickness >= 3 mm and enhancement >=46 % showing sensitivity, specificity and accuracy of 91%, 89% and 91%, respectively, with good agreement (k = 0.70). The sonographic score of severity obtained a sensitivity of 90% and specificity of 74% in the detection of severe endoscopic recurrence. The presence of any of the next three parameters, thickness >= 6 mm, thickness between 5-6 mm with mural enhancement or the presence of extraintestinal complications showed the best results for the diagnosis of severe recurrence (sensitivity 90%, specificity 87% and accuracy 89%).

CONCLUSION

The combination of neoterminal ileum wall thickness and the parameters of contrast enhanced ultrasound (CEUS) show excellent sensitivity and specificity for the detection of postoperative recurrence in CD and can predict its severity.

CLINICAL RELEVANCE/APPLICATION

CEUS is a tool that can increase our confidence in both postoperative recurrence detection and severity assessment in Crohn´s disease. The application of CEUS in the management of this type of patients can be an alternative to colonoscopy in the follow-up.

SSE11

Genitourinary (GU Intervention: Non-prostate)

Monday, Nov. 27 3:00PM - 4:00PM Room: E351

GU IR MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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K. Pallav Kolli, MD, San Francisco, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSE11-01 Clinical Outcome of Uterine Fibroids Treatment: MR Guided High Intensity Focused Ultrasound Compared to Current Therapeutic Strategies

Monday, Nov. 27 3:00PM - 3:10PM Room: E351

Participants
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PURPOSE

To prospectively evaluate clinical outcome of Magnetic Resonance Focused Ultrasound (MRgFUS), Uterine Artery Embolization (UAE) and Surgery in the treatment of Symptomatic Uterine Fibroid.

METHOD AND MATERIALS

585 symptomatic uterine fibroids underwent to pre-treatment MR evaluation in order to assess myoma characteristics and MRgFUS eligibility. 187 (32%) were considered eligible to MRgFUS and treated in our department using ExAblate-InSightec, while 398 resulted ineligible and were directed toward other therapeutic strategies. Of these, 137 underwent to UAE, 143 to myomectomy and 61 to hysterectomy. Clinical outcome for each treatment was evaluated comparing pre-treatment Symptoms Severity Score (SSS) with post-treatment SSS at 3-month and 12-month follow-up. Data concerning number and type of complications, days of hospitalization and days of convalescence were also collected and compared.

RESULTS

SSS mean reduction at 3 and 12-months was of 27,4% and 56,3%, respectively, for MRgFUS group; 48,7% and 56,9% for UAE group; 69,8% and 67,1% for myomectomy group; 96,6% and 94,5% for hysterectomy group. MRgFUS group demonstrated fewer complications (4 patients, 2,3 %), while the major adverse events rate was reported in UAE group (33 patients, 25,4 %). All MRgFUS patients were treated in outpatient setting, while mean days for hospitalisation and convalescence for other groups were respectively 3,4±2 and 11,7±9 days for UAE group; 4,1±2 and 16,9±12 days for myomectomy group; 4,5±1 and 24,6±14 days for hysterectomy group.

CONCLUSION

Clinical efficacy of MRgFUS for uterine fibroids treatment is comparable to UAE but slightly lower than myomectomy. However, MRgFUS is feasible in an outpatient setting and adverse events rate is significantly lower than other therapeutic strategies.

CLINICAL RELEVANCE/APPLICATION

MRgFUS is a new therapeutic strategy for symptomatic uterine fibroids, representing a non-invasive, safe and effective choice for selected patients.

SSE11-02 Percutaneous Ablation Therapy of Small Renal Tumors in Healthy Patients: A First Line Treatment

Monday, Nov. 27 3:10PM - 3:20PM Room: E351

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The purpose of our study is to evaluate the oncologic outcomes of ablative percutaneous therapies, such as radiofrequency (RFA) and cryoablation (Cry), used as first-line therapy for small renal masses (SRM) (T1a) in healthy / surgical patients.

METHOD AND MATERIALS

This study consisted of an institutional review board approved retrospective review at a multicentric center. Between November 2010 and July 2016, 85 healthy patients (those with an American Society of Anesthesiologists [ASA] physical status classification score of 1 or 2) with 95 SRM who underwent RFA (n=19) or cryoablation (n=76) were identified with a median largest tumor diameter of 2,4 cm (range 0,7 - 4,0 cm). Inclusion criteria were: American Society of Anesthesiologists [ASA] physical status classification score of 1 or 2; a diagnostic biopsy prior to the treatment; a malignant T1a renal tumor; and more than 6 months follow-up. Patients with an identified genetic disease predisposing them to RCC were excluded from the analysis. Patients who had undergone a previous intervention in the ipsilateral kidney were not excluded, based on ASA criteria. The minimally invasive approach, such as ablation therapies, was achieved either by the patient's choice or after multidisciplinary discussion. Patients were followed up with contrast-enhanced CT or MRI at 3, 6, 9 and 12 months and every 6 months thereafter sequentially. Oncological outcomes were calculated from the time of the ablation therapy.

RESULTS

Technique effectiveness was almost 98% (93 of 95). Median follow-up was 19 months (range 6-77). LTP were found in two patients (2%) with a median follow-up tume 11 months. All LTP were retreated successfully with ablation percutaneous therapy. Median LTPFS could not be calculated due to the fact that most of the patients in the study were still alive at the conclusion of the study period. No patient developed metastatic renal cell carcinoma (RCC) and none died from RCC.

CONCLUSION

Percutaneous ablations therapies seem to be a reasonable option to treat SRM as the first line due to the similarly oncological outcomes to the surgery in healthy patients.

CLINICAL RELEVANCE/APPLICATION

Percutaneous ablations therapies may be a reasonable treatment choice for the SRM in healthy patient.

SSE11-03 Percutaneous Microwave Ablation of Renal Cell Carcinoma

Monday, Nov. 27 3:20PM - 3:30PM Room: E351

Participants
Sepideh Shakeri, Los Angeles, CA (*Presenter*) Nothing to Disclose
Allan Pantuck, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
Anthony Sisk, DO, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
David S. Lu, MD, Los Angeles, CA (*Abstract Co-Author*) Consultant, Medtronic plc; Speaker, Medtronic plc; Consultant, Johnson & Johnson; Research Grant, Johnson & Johnson; Consultant, Bayer AG; Research Grant, Bayer AG ; Speaker, Bayer AG
Steven S. Raman, MD, Santa Monica, CA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess the safety and efficacy of image guided Microwave ablation (MWA) in biopsy - proven renal tumors within a minimum of 1- year postablation follow-up.

METHOD AND MATERIALS

In this retrospective study, 95 biopsy - proven renal tumors in 73 patients who underwent the renal MWA procedure from 2013 to 2016 at our institution were evaluated. This was an institutional review board-approved study. Data collected included demographic data, tumor characteristic data, procedural protocols and clinical follow-up visits within a 1 year. Primary outcomes were assessed by technical success, local recurrence-free (LRFS), and complications. Technical success was evaluated with Imaging immediately after MWA. Presence LRFS was examined with Imaging at 3-month target intervals for the first 2 years. Complications were categorized using the Clavien-Dindo classification system.

RESULTS

73 patients with 95 biopsy-proven renal lesions within 1 year postablation follow up were included. The mean patient age was 64(27-93) years and 63% were male. The mean tumor size was 2.7cm (0.8-7.4). 19% were benign while 81 % were RCC with clear cell 61 %(58/95), papillary13 %(12/95), chromophobe1.2%(1/95),oncocytoma 15% (14/95) and the rest were metastatic, unclassified lesions and benign cyst. Tumors were located 56% in the left kidney and most 39%(37/95) in lower pole.89/95 lesions were treated in a single encounter with 94% technical success but 6%(6/95) required a second ablation which most was 83%(5/6) CC with mean size of 4.1cm.The primary and secondary technical and overall technical success rate was 94%,100% and 100% respectively.The local recurrence rate was10.5% (10/95) with mean tumor size of 3.3cm and most 50%(3/6) had Interpolar location.The highest recurrence rate was in 70%(7/10) CC,10% Papillary (1/10) and the rest were unclassified and metastatic tumors. The complication rate was 7%(6/95) with minor complication (hematoma and severe pain) and no major one.The mean cancer-free survival was 11.9 months. All patients (99.4%) are alive only one patient died with unrelated cause (Melanoma,metastasis RCC) to the MW ablation.

CONCLUSION

Image-guided MWA appears to be a reliable and effective treatment option with low recurrence and complication rates in early

Image-guided MWA appears to be a reliable and effective treatment option with low recurrence and complication rates in early (1year) postablaton follow up.

CLINICAL RELEVANCE/APPLICATION

Percutaneous Microwave Ablation has achieved mature development in renal cancer therapy Since It shows the great safety and efficacy.

SSE11-04 The Increasing Utilization of Percutaneous Radiofrequency- and Cryo-ablation of Kidney Tumors in Recent Years

Monday, Nov. 27 3:30PM - 3:40PM Room: E351

Participants
Ali B. Syed, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
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Laurence Parker, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Percutaneous radiofrequency ablation (PRFA) and percutaneous cryoablation (PCRYO) have been billable since 2006 (PRFA) and 2008 (PCRYO). They are alternatives to surgical treatment. Our purpose was to study trends in their use compared with similar surgical approaches, and to determine the degree to which radiologists participate.

METHOD AND MATERIALS

The data source was the Medicare Part B Physician/Supplier Procedure Summary Master Files for 2003-2015. Procedure codes for PRFA, PCRYO, laparoscopic ablation, and open ablation were selected. Volumes for each of these ablative approaches were tracked. Medicare specialty codes were used to identify the specialty of the provider of each service. The code for partial nephrectomy was also studied for comparison.

RESULTS

Medicare volume of percutaneous ablation (both PRFA and PCRYO combined) was 927 in 2006. It then increased steadily, reaching 3378 in 2015 (+526%). Radiologists have always done the vast majority of these interventions; their share in 2015 was 89.9% while urologists' share was 9.0%. Of the percutaneous procedures that year, 33% were PRFA and 67% were PCRYO. Laparoscopic ablation volume was 452 in 2003, peaked at 1691 in 2007, but then declined sharply over the ensuing years to 470 in 2015. Virtually all of these were done by urologists. Open ablation volume was 241 in 2006 (the first year a code was available), increased to 260 in 2007, but then declined sharply to 84 in 2015. Almost all were done by urologists. Partial nephrectomy volume hovered in the 3400-3700 range but then began to drop in 2013, 2014, and 2015. Volume in 2015 was 2540.

CONCLUSION

Use of percutaneous ablation of renal lesions (both PRFA and PCRYO) has grown rapidly in recent years. By comparison, laparoscopic ablation and open ablation volumes have dropped sharply. The percutaneous approach is now used with considerably greater frequency than even partial nephrectomy. Radiologists strongly predominate in the percutaneous procedures. PCRYO is used twice as often as PRFA.

CLINICAL RELEVANCE/APPLICATION

Percutaneous techniques now appear to be the preferred approach in many patients with renal tumors, outstripping all 3 surgical approaches.

SSE11-05 Submucosal vs Intramural Uterine Fibroids (UFs): Follow-Up in Patients Treated by MRgFUS (Magnetic Resonance-Guided Focused Ultrasound Surgery)

Monday, Nov. 27 3:40PM - 3:50PM Room: E351

Participants
Sonia Iafrate, L'Aquila, Italy (*Presenter*) Nothing to Disclose
Ilaria Capretti, LAquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Ester Cannizzaro, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
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Francesco Arrigoni, Coppito, Italy (*Abstract Co-Author*) Nothing to Disclose
Aldo Victor Giordano, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Sara Mascaretti, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Giulio Mascaretti, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Carlo Masciocchi, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess the volume reduction and, symptom improvement rate following MRgFUS in patients affected by submucosal and intramural fibroids 2 years after treatment of MRgFUS.

METHOD AND MATERIALS

A total of 35 women, aged between 38 and 52, with only one symptomatic uterine fibroid underwent MRgFUS between February 2014 and February 2015.They were studied with preliminary MRI and UFs were classified with the FIGO staging system. Thirteen/35

patients were affected by submucosal fibroids (GROUP A, 3 of type 0, 4 of type 1 and 6 of type 2). They mainly were affected by reproductive problems but also by dismenoerrea. Twenty-two/35 patients were affected by intramural fibroid (GROUP B, 7 of type 3, 8 of type 4 and 7 of type 5) and were symptomatic for abnormal uterine bleeding, pelvic pressure and menorrhagia.The following parameters were evaluated: the non-perfused-volume (NPV) that represent the treated area immediately after treatment; the reduction of UFs and, the clinical symptomatology (evaluated by Symptoms severity score questionnaire (UFS-QOL).

RESULTS

All treated patients showed a very good procedural outcome with a mean initial extension of the NPV about 80-90 %. After 2 years from the MRgFUS, in the GROUP A, 8/13 showed progressive reduction of the UFs with a restoration of uterine wall morphology. Four/13 showed a complete disappearance of the UFs and in one patient, the fibroid of type 0 were partially expelled from the uterine cavity, without necessity of hysteroscopy. Also in the GROUP B we recorded a reduction in UFs volume , (18/22 about 70%, and 4/22 about 90%). In addition, all the women experienced an improvement of UFS-QOL around 90%, when compared with the pre-MRgFUS and no severe adverse events were identified in these patients during and post the procedure.

CONCLUSION

A sustained symptomatic improvement may be observed in patients affected by both submucosal and intramural uterine fibroids that underwent to MRgFUS, along the 2 year-follow-up.

CLINICAL RELEVANCE/APPLICATION

To improve the management of the patients affected by symptomatic submucosal and intramural uterine fibroids with mini-invasive treatment.

SSE11-06 Comparison of General Anesthesia and Conscious Sedation during Percutaneous Radiofrequency Ablation of T1a Renal Cell Carcinoma

Monday, Nov. 27 3:50PM - 4:00PM Room: E351

Participants
Byung Kwan Park, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

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PURPOSE

Percutaneous radiofrequency ablation (RFA) is so painful that this treatment requires pain control such as conscious sedation (CS) or general anesthesia (GA). It is still unclear which type of anesthesia is better for treatment outcomes of renal cell carcinoma (RCC). This study aimed to compare GA and CS in treating patients with RCC with RFA.

METHOD AND MATERIALS

Between 2010 and 2015, 51 patients with biopsy-proven 51 RCCs (<4 cm) were treated with CT-guided RFA. GA was performed in 41 and CS in 10 patients. Tumor size, local tumor progression, metastasis, major complication, effective dose, glomerular filtration rate (GFR) difference, and recurrence-free survival rate were compared between these groups.

RESULTS

The mean tumor size was 2.1 cm in both groups (p=0.673). Local tumor progression occurred in 0% (0/41) of GA group, but in 20% (2/10) of CS group (p=0.035). Metastases in these groups occurred in 2.4% (1/41) of GA group and 10% (1/10) of CS group (p=0.357). No major complications developed in either group after the first RFA session. The mean effective doses in these groups were 21.7 mSv and 21.2 mSv, respectively (p=0.868). The mean GFR differences in GA and CS groups were -13.5 mL/min/1.73m2 and -19.1 mL/min/1.73m2, respectively (p=0.575). Two-year recurrence-free survival rates in these groups were 97.5% and 78.8%, respectively (p=0.043).

CONCLUSION

GA may provide lower local tumor progression and better intermediate outcomes than CS in treating small RCCs with percutaneous RFA.

CLINICAL RELEVANCE/APPLICATION

GA instead of CS is recommended for pain control in treating a small RCC with image-guided RFA.

SSE12

Genitourinary (Imaging of Renal Stones)

Monday, Nov. 27 3:00PM - 4:00PM Room: E353A

CT GU

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Steven C. Eberhardt, MD, Albuquerque, NM (*Moderator*) Nothing to Disclose
Sadhna Verma, MD, Cincinnati, OH (*Moderator*) Nothing to Disclose

Sub-Events

SSE12-01 Low Bone Mineral Density on CT Predicts High Urinary Calcium, Low Citrate, and Larger Urinary Calculi

Monday, Nov. 27 3:00PM - 3:10PM Room: E353A

Awards
Student Travel Stipend Award

Participants
Ryan Ward, MD, Cleveland, OH (*Presenter*) Nothing to Disclose
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Juan Calle, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Nephrolithiasis is associated with systemic conditions including low bone mineral density (BMD), which may correlate with hypercalciuria in kidney stone formers (KSF). Typically, low BMD is diagnosed with dual-energy x-ray absorptiometry. We evaluated the association of vertebral bone mineral density on CT with 24-hour urine parameters in KSF.

METHOD AND MATERIALS

99 KSF who had CT and 24-hour urine studies were retrospectively evaluated. BMD was estimated using an oval ROI on L1 trabecular bone. A literature-based threshold for a balanced sensitivity (73.9%) and specificity (70.6%) of 160 HU was used to distinguish normal from low BMD. Univariate and multivariate logistic regression analysis was performed to compare patients with low and normal BMD. Multivariate linear regression was performed to assess for variables associated with 24-hour urine parameters.

CONCLUSION

CT-based diagnosis of low mineral bone density is associated with larger urinary calculi and derangements in 24-hour urine calcium and citrate.

CLINICAL RELEVANCE/APPLICATION

CT-based diagnosis of low mineral bone density is associated with larger urinary calculi and derangements in 24-hour urine calcium and citrate.

SSE12-02 Comparison of Detection Rate for Uric Acid Uroliths among Variable Parameters of CT: Phantom Study

Monday, Nov. 27 3:10PM - 3:20PM Room: E353A

Participants
Jin Kyem Kim, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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Dae Chul Jung, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To investigate whether uric acid stone can be detected by reduced radiation dose using 160mm ultra-wide coverage CT after

loading uroliths collected from the human body into the phantom.

METHOD AND MATERIALS

This study was approved by IRB. Six uric acid stones (size range from 1.8mm to 11mm) derived from the patients were embedded into silicon cylinder model, and then it was inserted into the human phantom along the ureter course. CT scan was undertaken with two sessions (abdominal cavity and pelvic cavity, respectively) with the same silicon model by various combinations of different tube-voltage (100 kVp, 80 kVp, 70 kVp) and tube-current (300 mA, 250 mA, 200 mA, 150 mA, 100 mA) using 160mm ultra-wide coverage CT. Three radiologists evaluated the presence of uric acid stones in each data set. The radiation dose was reported on CT system after CT acquisition was finished. The reader-averaged detection rate was compared using logistic regression with generalized estimating equation.

RESULTS

The radiation dose was from 6.32 mGy (CTDIvol) with 100kVp and 300mA, to 0.69 mGy (CTDIvol) with 70kVp and 100mA. The overall reader-averaged detection rate was from 50.00 to 88.98. The reader-averaged detection rate showed significant different only in tube-voltage and tube-current of abdomen ($p=0.0004$, <0.0001). The stone over 4 mm was detected in all parameter sets except two parameter sets (70kVp with 100 and 150mAs).

CONCLUSION

Ultralow-dose CT showed the promising result for uric acid stone detection in a phantom study with profound radiation dose reduction.

CLINICAL RELEVANCE/APPLICATION

We present the detection rate of the uric acid stone in a variable parameter using a phantom. Our result showed the possible application of ultralow-dose CT, even with 70kVp, for the detection of uric acid stones and clinical study needs to be followed to confirm our results.

SSE12-03 Uric Acid versus Non-Uric Acid Urinary Stones: Differentiation with CT Texture Analysis

Monday, Nov. 27 3:20PM - 3:30PM Room: E353A

Participants
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Hao Sun, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To investigate the diagnostic accuracy of CT texture analysis (CTTA) to differentiate uric acid (UA) from non-UA urinary calculi with ex vivo Fourier transform infrared spectroscopy (FT-IR) as the reference standard

METHOD AND MATERIALS

In this institutional review board-approved retrospective case-control study, 14 patients with 18 UA stones and 34 patients with 35 non-UA stones were identified from the database. All the patients had preoperative unenhanced CT evaluation and underwent surgical removal of the stones subsequently. CTTA was performed on unenhanced CT images by using TexRAD software. Receiver operating characteristic (ROC) curves were performed and the area under the ROC curve (AUC) was calculated for texture parameters that were significantly different. The optimal discriminative features were used to train support vector machine (SVM) classifiers. Diagnostic accuracy of textural features was evaluated and 10-fold cross validation was performed

RESULTS

Compared to non-UA stones, UA stones had significantly lower Mean at all texture scales, lower SD and MPP at all except coarse texture scales, lower skewness at no filtration and higher kurtosis at no filtration and fine texture scale ($P<0.001$). The average SVM accuracy of textural features for differentiating UA from non-UA stones ranged from 77.4% to 98.1% (after 10-fold cross validation). A model incorporating Mean, SD, MPP and kurtosis quantified from no filtration resulted in an AUC of 0.99 ± 0.01 with a SVM accuracy of 98.1%, sensitivity of 100% and specificity of 94.4%.

CONCLUSION

CTTA on unenhanced CT images could be used to accurately differentiate UA from non-UA urinary stones

CLINICAL RELEVANCE/APPLICATION

CTTA could help to characterize urinary stone composition beyond the basic evaluation and allow optimization of treatment options for patients with urolithiasis.

SSE12-04 Low-Dose CT of Suspected Urolithiasis: Diagnostic Yield for Assessment of Alternative Diagnoses

Monday, Nov. 27 3:30PM - 3:40PM Room: E353A

Participants
Frank Oliver G. Henes, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
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Marc Regier, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
Sarah Keller, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
Luis Kluth, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose

Gerhard B. Adam, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
Julius M. Weinrich, Hamburg, Germany (*Presenter*) Nothing to Disclose

PURPOSE

To assess the diagnostic yield of low-dose computed tomography (LDCT) for alternative diagnoses (AD) in patients with suspected urolithiasis.

METHOD AND MATERIALS

776 consecutive patients who underwent non-contrast enhanced abdominal CT for evaluation of suspected urolithiasis were included in this study. All examinations were performed with a low-dose CT protocol; images were reconstructed using an IR system (iDose4™, Philips Healthcare, Best, the Netherlands). The leading CT diagnosis was recorded for each patient and compared with the final clinical diagnosis, which was referred to as the reference standard. The final clinical diagnosis was determined by review of hospital discharge records and reports of surgical procedures.

RESULTS

The prevalence of urolithiasis was 82.5% (640/776). LDCT reached a sensitivity of 94.1% (602/640), a specificity of 100% (136/136) and an accuracy of 95.1% (738/776) for the detection of urolithiasis. In 91 patients without urolithiasis (66.9%) AD were established as final clinical diagnoses. AD were most commonly located in the genitourinary (n=51) and gastrointestinal tract (n=18). LDCT correctly provided AD in 57 patients (62.6%) and was false negative in 34 patients (37.4%). The most common clinical AD missed in LDCT were urinary tract infections (n=22). Seven diagnosis missed in LDCT were located outside of the scan-volume. In 43 patients neither LDCT nor clinical workup could establish a final AD (5.5%). Sensitivity, specificity and accuracy of LDCT for detection of AD was 62.6% (57/91), 95.6% (41/43) and 73.5% (100/136), respectively.

CONCLUSION

LDCT enables the diagnosis of the majority of AD in the setting of suspected urolithiasis. Most frequent alternative diagnoses missed by LDCT in this study were urinary tract infections or diagnoses located outside of the scan-volume.

CLINICAL RELEVANCE/APPLICATION

Although the prevalence of urolithiasis in patients undergoing CT is high, there is still the need to the detect significant alternative pathologies by low-dose protocols. Besides genitourinary and gastrointestinal disorders osseous pathologies in this patient group are frequent findings.

SSE12-05 Urinary Stone Detection with Deep Convolutional Neural Networks on Unenhanced Computed Tomography Images

Monday, Nov. 27 3:40PM - 3:50PM Room: E353A

Awards
Student Travel Stipend Award

Participants
Anushri Parakh, MBBS, MD, Boston, MA (*Presenter*) Nothing to Disclose
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Jung Hwan Cho, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Synho Do, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Dushyant V. Sahani, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company; Medical Advisory Board, Allena Pharmaceuticals, Inc

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PURPOSE

The study aimed to determine if deep-learning models can perform detection of clinically relevant urinary stone disease on unenhanced CT images with high-fidelity.

METHOD AND MATERIALS

Retrospective identification of patients (n=289) who presented with suspected renal stone disease and underwent CT on Discovery CT 750 HD, GE Healthcare between January-December 2016 was performed. Patients were categorized according to presence (n=128) and absence (n=161) of stones. 13,278 image slices were first used to train for anatomy recognition. Of the 544 total image slices (ISf) each for stone and no-stone, 437 served as training (ISt) and 107 as validation (ISv) set for DL. Stones were grouped according to size: Group A < 4mm (ISf 89, ISt 72, ISv 17), Group B 4-9.9mm (ISf 287, ISt 230, ISv 57) and Group C > 10mm (ISf 168, ISt 135, ISv 33). Area (AUC) under the receiver-operating-characteristics curve analyses for total and size-based accuracy for stone detection was calculated in abdomen and bone windows.

RESULTS

The accuracy for stone detection was 91.12% with 0.964 AUC. DL correctly predicted 14/17 in Group A, 51/57 in Group B and 32/33 in Group C. No significant difference was found in detection reults on abdomen and bone windows. The incorrectly classified cases were due to extremely small stones, presence of phlebolith along the ureter or anatomical misregistration.

CONCLUSION

DL has the potential to segment anatomy and detect urinary stone disease, irrespective of location in the urinary tract and stone size.

CLINICAL RELEVANCE/APPLICATION

There has been an increase in the utilization of CT for urinary stone disease. Being relatively task-specific, DL for stone detection has the potential to be applied in real-time as a diagnostic support by pre-analyzing and triaging positive cases for radiology read-

outs. This would improve workflow and patient management in an emergency setting.

SSE12-06 Prediction of Successful Shock Wave Lithotripsy: Potential of Texture Analysis and Machine Learning in Computed Tomography

Monday, Nov. 27 3:50PM - 4:00PM Room: E353A

Participants
Manoj Mannil, Zurich, Switzerland (*Presenter*) Nothing to Disclose
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Christian Fankhauser, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Hatem Alkadhi, MD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To apply texture analysis (TA) in computed tomography (CT) of urinary stones and to correlate TA findings with the number of required shockwaves for successful shock wave lithotripsy (SWL).

METHOD AND MATERIALS

CT was performed on thirty-four urinary stones in an in-vitro setting. Urinary stones underwent SWL, the number of required shockwaves for disintegration was recorded. TA was performed after postprocessing for pixel spacing and image normalization. Feature selection and dimension reduction were performed according to inter- and intrarater reproducibility and by evaluating the predictive ability of the number of shock waves along with the degree of redundancy between TA features using machine learning algorithms. Three regression models were tested: (1) linear regression with elimination of colinear attributes (2), sequential minimal optimization regression (SMOreg) using machine learning, and (3) simple linear regression model of a single TA feature with lowest squared error. Urinary stone samples were grouped using the median of required shockwaves. Correlation coefficients were calculated between each model and absolute number of shockwaves. Receiver operating characteristics (ROC) analysis was performed for dichotomized results, areas-under-the-curve (AUC) were calculated.

RESULTS

92 out of 308 TA features with excellent reproducibility (ICC > 0.8) remained. Highest correlations were found for the linear regression model (r=0.55): y=0.4892*Percentile10-37.6313*S33SumAverg+2023.7399, followed by the sequential minimal optimization regression model (r=0.51) and simple linear regression model (r=0.47). Using the median number of required shockwaves (n=72) as cutoff showed highest AUCs for the SMOreg model (AUC=0.838): y=0.4491*ZPercentile10+0.0044*ZS11InvDfMom-0.0294*ZS33SumAverg-0.0804*ZS4-4SumVarnc+0.0564.

CONCLUSION

Our in-vitro study indicates the potential of TA of urinary stone CT enabling the prediction of successful stone disintegration with SWL with high accuracy.

CLINICAL RELEVANCE/APPLICATION

Successful prediction of stone disintegration with SWL using TA in CT may prevent repeated SWL treatment or alternative, more invasive procedures associated with higher morbidity and costs.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
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SSE13

Health Service, Policy and Research (Economic Analyses)

Monday, Nov. 27 3:00PM - 4:00PM Room: S104B

HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Tessa S. Cook, MD, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose
Gelareh Sadigh, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

Sub-Events

SSE13-01 A Comparison of Time-Driven Activity-Based Costing to RVU-Based Absorption Costing in Breast Imaging Services

Monday, Nov. 27 3:00PM - 3:10PM Room: S104B

Awards
Student Travel Stipend Award

Participants
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John Wolfe, Nashville, TN (*Abstract Co-Author*) Nothing to Disclose
Stephanie C. Kurita, MD, Nashville, TN (*Abstract Co-Author*) Nothing to Disclose
Richard C. Pierce, MBA, Nashville, TN (*Abstract Co-Author*) Nothing to Disclose
Richard W. Grooms III, BS, MBA, Nashville, TN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Value-based health care delivery models, where value is defined as the outcomes achieved per unit cost, necessitate accurate cost measurements. While traditional accounting methods such as absorption costing (AC) rely upon relative value units (RVUs) to estimate costs, time-driven activity-based costing (TDABC) uses process mapping to measure costs of resources utilized. We compared RVU-based AC (R-AC) and TDABC methods in estimating the costs of breast imaging services.

METHOD AND MATERIALS

Costs of screening MG, diagnostic MG, breast ultrasound (US), stereotactic biopsy, and US-guided biopsy were calculated using R-AC and TDABC models. For R-AC, the ratio of total costs (direct, indirect, and overhead) to total RVUs generated was multiplied by the RVUs assigned to a specific procedure. For TDABC, cost capacity rates of personnel, equipment, space, and consumables were combined with process maps based on actual resource utilization (Figure).

RESULTS

R-AC estimates of both screening and diagnostic MG costs were $90.07, given their identical RVU assignment. TDABC estimates were lower for screening MG ($56.59), but higher for diagnostic MG ($127.38). Similarly, TDABC costs exceeded R-AC costs for diagnostic MG and breast US ($211.82 vs $170.79). However, TDABC significantly underestimated costs for US-guided biopsy ($376.44 vs $2590.69) and stereotactic biopsy ($406.49 vs $2,666.81).

CONCLUSION

TDABC is based on actual resource utilization and more accurately reflects costs of screening MG, diagnostic MG, and breast US than R-AC, as RVU assignments are not always reflective of work involved. However, TDABC significantly underestimates the costs of biopsies compared to R-AC, as TDABC does not take into account overhead costs, unused capacity, and waste. While TDABC provides a more accurate measure of resource utilization to help refine cost estimates and understand what costs "should be", R-AC provides a global assessment, taking into account what costs "are". These findings carrying significant implications in understanding costs of providing imaging services in the current health care landscape, particularly with the rise of altenative payment models and bundled payments.

CLINICAL RELEVANCE/APPLICATION

TDABC accurately quantifies costs of imaging services and identifies cost-saving opportunities, but understimates unused capcity costs captured by R-AC.

SSE13-02 ED Length-of-Stay for "Rule-Out" Appendicitis Patients is Decreased When Normal CT Findings are Directly Communicated to Referring Clinicians

Monday, Nov. 27 3:10PM - 3:20PM Room: S104B

Participants
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PURPOSE

Verbal communication is typically used by ED radiologists to report important findings likely to impact immediate patient care, but less frequently used to report normal findings; the value of notifying ED clinicians that an "actionable" negative result is available that could facilitate ED discharge is unknown. Our aim was to correlate verbal communication of CT results with report turnaround time (TAT) and ED length of stay (LOS), for patients presenting with right-lower-quadrant (RLQ) pain who received a "rule-out appendicitis" CT protocol.

METHOD AND MATERIALS

Abdominal CT reports from ED patients (Apr-Nov 2016) with suspected acute appendicitis ("Appy") were retrieved from our radiology database. Frequency, time & type of verbal communication were extracted from reports and correlated with diagnosis, TAT & ED LOS. Chi-square and T-test were used.

RESULTS

Of 220 reports, 37% (82/220) were positive for Appy, 36% (80/220) were normal, and 27% (58/220) were positive for other causes of RLQ pain. Overall, 34% (75/220) of reports had documentation of direct communication. Positive Appy reports were communicated faster & more frequently (34+/-26 min; 61%, 50/82) than normal or other diseases (72+/-65 min, p=0.01; 18%, 25/138, p<0.001). In patients with normal reports (n=80), mean ED LOS was shorter by 123 min with communication (n=4/80, 5%, 412+/-67 min) versus without (n=76/80, 95%, 535+/-409 min, p=0.04), without difference in TAT (p=0.8). With positive appendicitis reports (n=82), TAT was shorter for non-communicated than for communicated reports (49+/-44 min versus 90+/-72min; p=0.002), without difference in ED LOS (p=0.3). For other diseases (n=58), there was no difference in TAT (p=0.3) or ED LOS (p=0.07) between communicated and non-communicated reports.

CONCLUSION

Verbal communication of CT results was associated with longer TAT in patients with confirmed Appy, and shorter ED LOS in patients with normal CT's without Appy.

CLINICAL RELEVANCE/APPLICATION

Although TAT is an accepted metric of "value-based" ED radiology performance, it does not account "for time-to-notification" of results to referring ED clinicians, which impacts ED LOS. A standardized, expedited system for immediate result notification - such as texting - might help improve ED LOS, especially in patients with normal exam findings who can be safely discharged.

SSE13-03 Cost-Effectiveness of Endovascular Thrombectomy in Acute Ischemic Stroke: The Impact of Patient Age from a United States Health Care Perspective

Monday, Nov. 27 3:20PM - 3:30PM Room: S104B

Awards
Trainee Research Prize - Resident

Participants
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Konstantinos Dimitriadis, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Thomas Huber, MD, Munich, Germany (*Abstract Co-Author*) 04-11-2017:- Consultant for Brainlab AG (Feldkirchen, Germany), ended 09/2016 - not related to the present study; - Consultant for Smart Reporting GmbH (Munich, Germany), started 03 / 2017 - not related to the present study.
Wieland H. Sommer, MD, Munich, Germany (*Abstract Co-Author*) Founder, Smart Reporting GmbH
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PURPOSE

Endovascular thrombectomy in addition to IV thrombolysis (EVT+IVT) has been proven to be more effective compared to IV thrombolysis alone (IVT alone) in acute ischemic large vessel occlusion stroke. Our aim was to determine the impact of patient age on cost-effectiveness of EVT+IVT.

METHOD AND MATERIALS

A decision model based on Markov simulations estimated lifetime costs and quality-adjusted life years (QALY) associated with both strategies (see Figure 1). The analysis was performed in a United States setting from a health care perspective. Model input

parameters were based on best available and most recent evidence in the published literature (see Table 1), including a meta-analysis of 5 recent randomized clinical trials (MR CLEAN, ESCAPE, REVASCAT, SWIFT PRIME, EXTEND-IA). The impact of patient age on the parameters was considered. Deterministic (DSA) and probabilistic sensitivity analyses (PSA) were performed, the latter using 10,000 Monte Carlo simulation runs to estimate the overall uncertainty of the results. Net monetary benefit (NMB), incremental costs (IC), incremental effectiveness (IE), and incremental cost-effectiveness ratios (ICER) were derived. The willingness to pay (WTP) thresholds were set to $50/$100/$150,000/QALY respectively.

RESULTS

The DSA and PSA performed with patient age at index stroke ranging from 50 to 100 years yielded incremental QALYs for EVT+IVT for every age level (see Table 2, Figure 2 and 3). Among patients aged 50-79 years, EVT+IVT additionally implied lower lifetime costs compared to IVT alone, and hence was the dominant strategy. For patients aged 80 years at index stroke, EVT+IVT implied incremental costs of $19,041 and incremental QALYs of 1.13, resulting in an ICER of $16,870/QALY with an acceptability rate of 99.9% at a WTP threshold of $100,000/QALY. Up to 100 years, EVT+IVT had acceptability rates of >80% and >96% at WTP thresholds of $100,000/QALY and $150,000/QALY respectively (see Figure 4).

CONCLUSION

EVT+IVT is a cost-effective therapy of large vessel occlusion stroke in all patient ages from 50 to 100 years. Our results suggest that there is no upper age limit to withhold EVT, neither from a medical point of view, nor from an economic perspective.

CLINICAL RELEVANCE/APPLICATION

EVT treatment is on the verge of large-scale implementation. Based on its cost-effectiveness, increased investments into the medical infrastructure to establish nationwide EVT access may be justified.

SSE13-04 Split-Bolus Dual-Enhancement Abdominal Pelvic Computed Tomography Angiography before Lung Transplantation: Image Quality, Protocol Design, and Resource Utilization

Monday, Nov. 27 3:30PM - 3:40PM Room: S104B

Participants
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PURPOSE

Pre-lung transplant suitability for high risk patients often requires screening for vascular integrity and solid organ malignancy. This, for most patients, utilizes two separate imaging studies: single-injection single-enhancement abdominal-pelvic CTA(*sCTA*) and an additional exam to assess for solid organ malignancy(using CT/MR/U/S). The purpose of this study is to assesses image quality and resource utilization for a single-injection split-bolus dual-enhancement abdominal-pelvic CTA(*dCTA*) for combined solid-organ and vascular assessment.

METHOD AND MATERIALS

In this single-center IRB-approved HIPAA compliant quality assessment study, 106 consecutive patients being evaluated for lung transplantation over a 12-month period, who underwent CTA abdomen-pelvis were included and divided into two cohorts: those imaged in the first 6 months underwent standard-of-care sCTA(cohort A; n,50; mean age,63y) and in later 6 months dCTA(cohort B; n,56; mean age,60y). Image quality of the vasculature was assessed by extraction of enhancement(HU) along the abdominal aorta through the right femoral artery in 1-mm increments using ImageJ software. Solid organ enhancement for liver and renal cortex were measured using a 1cm2 region-of-interest. Mean radiation exposure and intravenous contrast exposure, total and type of cost of studies for both subgroups was compared.

RESULTS

Mean(±coefficient-of-variance) vascular enhancement for sCTA and dCTA was 225HU(±0.36) and 235HU(±0.11;*P*0.09), respectively. Mean liver enhancement for the sCTA and dCTA was 65HU(±7) and 108HU(±41;*P*0.01). Mean renal enhancement for the sCTA and dCTA was 140HU(±42) and 218HU(±77;*P*0.02). Mean intravenous contrast exposure was 225mL and 131mL, respectively. Cohort A underwent 50 sCTA and 23 additional imaging studies (hence, mean radiation exposure 23mGy) for the total cost of $10,839 USD/patient. Cohort B underwent 56 dCTA exams (11mGy) at the cost of $8,623 USD/patient.

CONCLUSION

Single injection split-bolus dual enhancement abdomen pelvic CT protocol results in improved vascular enhancement and optimal portal-venous opacification for solid-organ assessment as a single CT examination with 54% reduction in radiation exposure, 42% reduction in IV contrast exposure and 11% reduction in cost.

CLINICAL RELEVANCE/APPLICATION

Combined dual-phase abdominal-pelvic CTA provides optimal vascular assessment and parenchymal enhancement with improved image quality, patient safety profile and lower cost.

SSE13-05 Radiology Exams on End-Stage Oncologic Patients before Hospice Admission

Monday, Nov. 27 3:40PM - 3:50PM Room: S104B

Participants
Elena Belloni, MD, Castel San Giovanni, Italy (*Presenter*) Nothing to Disclose
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PURPOSE

Data on radiology exams performed on end-stage oncologic patients before Hospice admission are scarce. The purpose of our study was to evaluate frequency, type and cost of diagnostic and interventional radiology exams performed on this population in the 90 days before admission to Hospice.

METHOD AND MATERIALS

Data of patients admitted to Hospice between January 2012 and June 2013 were cross-checked with the data of the Radiology Department archive. Frequency and type of the radiology exams performed on patients in the 90 days before Hospice admission were retrospectively analized across three 1-month periods, namely M-3, M-2, M-1, corresponding to 90-61, 60-31 and 30-1 days before admission, respectively. The Regional Health Care Range of Fees was used to determine the costs.

RESULTS

389 patients were admitted to Hospice in the 18-month period. In the 90 days before admission, 335 patients (86%) underwent 1543 radiology exams: 919 X-Rays, 555 CTs, 39 MRs, 30 interventional procedures. The cost of these services was € 106988, so distributed: € 19918 for X-Rays, € 73956 for CTs, € 9502 for MRs, € 3612 for interventional procedures. Across the three periods (M-3, M-2, M-1), both the proportions of examined patients and of performed exams varied significantly, increasing as Hospice admission approached. Similar results were obtained also when analyzing the types of radiology exams. During Hospice stay, only 25 patients (6%) underwent radiology exams.

CONCLUSION

A substantial number of end-stage oncologic patients underwent radiology exams in the 90 days before Hospice admission, and these number grew as Hospice access approached. These exams generated high expenditures for the National Health Service. In the end-of-life span, patient care should be devoted to improve the quality of life and not to try to prolong it. For this reason, diagnostic excesses should be avoided.

CLINICAL RELEVANCE/APPLICATION

A great number of radiology exams are performed on end-stage oncologic patients before Hospice admission, potentially configuring a form of diagnostic obstinacy and generating high expenditures.

SSE13-06 Patient Preferences for Receipt of Imaging Findings: A Systematic Review

Monday, Nov. 27 3:50PM - 4:00PM Room: S104B

Participants
Navneet Natt, Toronto, ON (*Presenter*) Nothing to Disclose
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PURPOSE

To promote patient-centered delivery of services in radiology, it is important to understand patient preferences and experiences as they undergo medical imaging procedures. The purpose of the study was to perform a systematic review of publications describing outpatient preferences for receipt of imaging findings.

METHOD AND MATERIALS

An information specialist was consulted to create a literature search strategy to query MEDLINE, Embase, CINAHL and Cochrane publications from 2000 to 2015. Two screening rounds and extraction were performed independently by two reviewers. Modified versions of the CASP and the NHLBI Quality Assessment Tools were used for critical appraisal. A narrative approach was used to synthesize evidence.

RESULTS

Of 25,455 entries initially identified, 22 were included. Quality ranged from low to medium. Generalizability was affected by narrowly-defined target groups and low response rates. Heterogeneity was observed in the framing of specific questions and whether preferences were evaluated via survey (n=14) or following an intervention (n=8). Surveys: There were four studies that queried desire to meet with a radiologist; 64-77% of respondents indicated 'yes'. The outlier (23% 'yes') was in the study that asked about abnormal results. In nine studies that queried preferences for who provide results, the ordering physician was preferred in five; results were equivocal when participants understood the radiologist's role. There were high-levels of interest in having direct access to results (81-99%). Interventions: When the effect of radiologist interactions were evaluated, 72-98% indicated a desire to consult with radiologists again in the future. There was a consensus that the interactions improved the experience and understanding of the diagnostic process.

CONCLUSION

Preferences varied by how questions were asked and what information was provided to participants. Those informed about the expertise of the radiologist indicated a stronger preference to consult with a radiologist than those who were uninformed. This was supported by studies that incorporated a radiologist consultation; participants felt it improved their experience and wanted similar consultations in the future.

CLINICAL RELEVANCE/APPLICATION

Careful design of radiologist consultation services, including addressing key knowledge gaps in participants, has the potential to positively impact the experience of patients receiving imaging services.

SSE14

Science Session with Keynote: Musculoskeletal (Upper Extremity)

Monday, Nov. 27 3:00PM - 4:00PM Room: E450B

CT MK MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Jenny T. Bencardino, MD, Lake Success, NY (*Moderator*) Nothing to Disclose
Adam C. Zoga, MD, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSE14-01 Musculoskeletal Keynote Speaker: Update on Upper Extremity Imaging

Monday, Nov. 27 3:00PM - 3:10PM Room: E450B

Participants
Lynne S. Steinbach, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

SSE14-02 4D MSK MRI: Feasibility in the TMJ and GHJ and Comparison with 2D Dynamic Evaluation

Monday, Nov. 27 3:10PM - 3:20PM Room: E450B

Participants
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PURPOSE

There are limited reports of 2D dynamic MR evaluation in the MSK system. These are appealing for evaluating dynamic stabilization in joints. 2D dynamic imaging has limited slice profile with out-of-plane movement of imaging targets. Our objective was to develop a 4D (3D volume + 1D time) technique with application in the temporomandibular (TMJ) and glenohumeral (GHJ) joints and compare to its 2D counterpart.

METHOD AND MATERIALS

4D MR technique was developed for in vivo imaging at 3-T (Toshiba), and compared with 2D dynamic technique. In a volunteer, TMJ during a mouth opening-closing was imaged with: 1) 2D FASE (single shot spin echo; TR=400 ms, TE=10 ms, ETS=5 ms, FA=90/160 deg, FOV=20 cm, matrix=160x160, slice=6 mm (single slice), and 3.3 frames per sec, fps); and 2) 3D FASE (similar to 2D except: FOV=25 cm, matrix=256x256, slice=2 mm (6 slices), 1.1 fps). GHJ was imaged during a medial rotation of a forearm with: 3) 2D FASE at 2.5 fps and 4) 3D FASE at 0.4 fps with 8 slices.

RESULTS

Dynamic 2D and 4D techniques both yielded images of the TMJ (Fig.1) and GHJ (Fig.2) that depicted major structures with good quality and contrast. For example, in the GHJ, SNR of humeral head was 9.0 and 12.6, and CNR was 8.0 and 11.6, for 2D and 4D respectively. In the TMJ, the movement of mandibular condyle (Fig.1, circle) can be seen against stationary temporal bone (Fig.1, star). In the GHJ, changing orientation of humeral head (Fig.2, star) and glenoid (Fig.2, circle) during forearm rotational motion is seen. 4D technique, however, offered a crucial advantage of volume acquisition. For both TMJ and GHJ, evaluation of the soft tissues (TMJ disc, biceps tendon in groove) through range of motion is important for diagnosis and treatment. With 2D imaging, target structure can move out of the imaging slice. The 4D acquisition remedies this, albeit at a slower frame rate.

CONCLUSION

This feasibility study suggests that 2D dynamic and 4D MR techniques are available for evaluation of MSK structures in real-time motion, and that 4D has added advantage in case where complex, out-of-slice motions are involved.

CLINICAL RELEVANCE/APPLICATION

The 4D MR technique has utility for evaluation of joint instability.

SSE14-03 Rapid High-Resolution MRI of Elbow Injuries: Comparison of a Novel 10-min 3D TSE Technique

Against a 20-min 2D TSE Standard of Reference

Monday, Nov. 27 3:20PM - 3:30PM Room: E450B

Participants
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PURPOSE

To test the hypothesis that a 4-fold accelerated 10-min 3D CAIPIRINHA SPACE prototype protocol is equivalent to a 2-fold accelerated 2D TSE standard for the MRI diagnosis of internal derangement of the elbow.

METHOD AND MATERIALS

Our study was approved by our internal review board. Following informed consent, 40 patients underwent 3T MRI of their symptomatic elbow consisting of six axial, sagittal and coronal IW and T2FS 2D TSE (20 min) and two sagittal isotropic IW and T2FS 3D TSE (10 min) pulse sequences. The novel 4-fold acceleration of the 3D SPACE TSE sequences was facilitated by bi-directional parallel imaging and CAIPIRINHA sampling pattern. Corresponding 2D and 3D TSE data sets were separated, anonymized and randomized into 80 studies and independently evaluated by two musculoskeletal radiologists. Outcome variables in each study included the integrity and diagnostic confidence of the 3 joints, 4 ligaments, 4 tendons, and 3 bones of the elbow. Descriptive statistics, inter-rater reliability, inter-modality concordance, and diagnostic confidence test were applied. A p-value of <0.05 was considered significant.

RESULTS

There was a high degree of inter-rater reliability with exact agreements of 78% for 2D and 89% for 3D studies ($p<0.05$). The degree of diagnostic concordance between 2D and 3D TSE was high with a Kendall's coefficient W for cartilage of 0.842, ligaments of 0.769, tendons of 0.890, and bone of 0.894. Raters diagnosed a total of 6 cartilage defects on 2D and 8 on 3D images, 14 ligament tears on 2D and 12 on 3D, 31 tendon tears on 2D and 33 on 3D, and 26 bone abnormalities on 2D and 28 on 3D. The disagreements between 2D and 3D diagnoses for cartilage, ligaments, tendons, and bone were 17.8%, 5.6%, 5.0%, and 3.8%, respectively. The readers' diagnostic confidence was significantly higher for 3D TSE ($p<0.05$).

CONCLUSION

For the diagnosis of internal derangement of the elbow, the presented 10-min 3D CAIPIRINHA SPACE MRI protocol is equivalent to a 20-min 2D TSE standard of reference. Radiologists' concordance and confidence were significantly higher for 3D studies, indicating a higher diagnostic definitiveness and possibly increased accuracy.

CLINICAL RELEVANCE/APPLICATION

Rapid 3D CAIPIRINHA SPACE TSE MRI is at least equivalent to a 2D TSE MRI reference standard for diagnosing elbow abnormalities and holds promise to substantially improve the efficiency of elbow MRI exams.

SSE14-04 Four-Dimensional Computed Tomography (4DCT) Evaluation of the Modified Radio-Ulnar Line in Correlation with Imaging Features of the Distal Radio-Ulnar Joint Osteoarthritis

Monday, Nov. 27 3:30PM - 3:40PM Room: E450B

Participants
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PURPOSE

Modified Radio-Ulnar line (mRU) is a previously validated and reliability tested index of the Distal RadioUlnar Joint (DRUJ) and ulnar head alignment. The purpose of our study was to investigate the association between mRU measurements derived from Four-Dimensional Computed Tomography (4DCT) examination with clinical symptoms and imaging features of DRUJ osteoarthritis (OA).

METHOD AND MATERIALS

This is an IRB approved HIPAA compliant retrospective evaluation of 18 wrists (10 patients with unilateral wrist pain and instability) that were prospectively recruited in our 4DCT cohort study. Imaging of the contralateral asymptomatic side was performed to aid the diagnosis in the symptomatic side. The 4DCT was obtained using a 320-row detector scanner (Aquilion One, Toshiba Medical Systems) in active pronation-supination. Our previous study confirmed the reliability of mRU measurements using 4DCT examination. The mRU measurements were obtained in pronation, midpoint and supination by a fellowship trained MSK radiologist. Presence of symptoms (yes vs. no) and the Kellgren-Lawrence grade of OA (0-4) were assessed in correlation with mRU measurements in active motion.

RESULTS

The mRU values indicated a significantly greater volar motion of the ulnar head in asymptomatic wrists (mRU mean values (standard error): -0.10 (0.03) vs. 0.10 (0.03); P<0.001) in supination. Changes in the mRU measurements from pronation to midpoint (mean change: 0.11 (0.03), P:0.002) and to supination (0.19 (0.03), P<0.001) were significant only in the asymptomatic wrists. Unlike wrists with KL grade >=2, wrists with KL grade <2 had significant changes in the mRU values while moving from pronation to midpoint (mean change: 0.09 (0.02), P:0.004) and from pronation to supination (0.14 (0.06), P:0.059). The mRU values in pronation were not associated with the presence of symptoms or DRUJ OA. However, mRU values in supination were significantly correlated with both the presence of symptoms (correlation coefficient: 0.796, P<0.001) and KL grade of DRUJ OA (correlation coefficient: 0.647, P:0.005).

CONCLUSION

Presence of clinical symptoms and imaging features of DRUJ OA severity are associated with restricted volar motion of the ulnar head (assessed by the mRU line) while moving from pronation to supination.

CLINICAL RELEVANCE/APPLICATION

4DCT can feasibly detect dynamic changes in DRUJ alignment that are associated with clinical symptoms and imaging features of DRUJ OA.

SSE14-05 ECU Pseudolesion: A Spectrum of Change with Radiologic-Pathologic Correlation

Monday, Nov. 27 3:40PM - 3:50PM Room: E450B

Participants
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PURPOSE

Axial MRI of the distal extensor carpi ulnaris (ECU) tendon commonly demonstrates increased central signal often attributed to tendinosis but recently described as 'ECU pseudolesion' from central tissue degeneration. On ultrasound (US), the ECU often appears heterogeneous, sometimes with a discrete cleft, even in asymptomatic patients which likely correlates with signal changes on MRI. The purpose of our study is to evaluate the distal ECU tendon by US, gross dissection and histologic evaluation to identify the ECU subsheath and elucidate the underlying cause of central signal abnormality.

METHOD AND MATERIALS

Distal ECU tendons in 28 cadaveric wrists were evaluated with static and dynamic US; images were reviewed in blinded fashion by two MSK radiologists for the presence of ECU subsheath (visible, not visible) and echogenicity of distal ECU tendon (homogeneous, heterogeneous, discrete cleft). 20 wrists were dissected by a plastic surgeon for gross evaluation of the ECU subsheath and distal ECU tendon to assess for split tear. Seven dissected ECU tendons were cross-sectioned and stained by one MSK pathologist for histologic evaluation.

RESULTS

The ECU subsheath was visible in 92.3% and 100% cases, with interreader reliability of 92%. No ECU subluxation was visualized in any wrist, with less than 40% volar displacement of the tendon during wrist rotation. In regards to echogenicity, interreader reliability was 54%, with a cleft noted in six cases by reader 1 but only one by reader 2. Of the 20 specimens dissected, all of them demonstrated an intact ECU subsheath and none of them demonstrated a tear. Of the 7 pathology specimens, all of them demonstrated internal bands of connective tissue between tendon bundles but within the tendon sheath and none of them demonstrated a tear.

CONCLUSION

The ECU subsheath is well visualized by US. Hypointensity in the distal ECU tendon on US represents bands of connective tissue, not tendinosis or longitudinal tear, and in some cases is contiguous with the external ECU tendon sheath on histologic evaluation.

CLINICAL RELEVANCE/APPLICATION

Distal ECU tendon often appears heterogeneous on US, sometimes with a discrete hypoechoic cleft, which is attributable to bands of connective tissue between tendon bundles and does not represent tendinosis or a longitudinal split tear. US is a reliable method to visualize the ECU subsheath, which can be assesed during dynamic maneuvers to diagnose ECU subluxation.

SSE14-06 Cost Effectiveness of MRI versus Ultrasound for the Detection of Symptomatic Full-Thickness Supraspinatus Tendon Tears

Monday, Nov. 27 3:50PM - 4:00PM Room: E450B

Participants
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PURPOSE

To determine the value of MRI and ultrasound-based imaging strategies in the evaluation of a hypothetical population with a symptomatic full thickness supraspinatus tendon (FTST) tear using cost effectiveness.

METHOD AND MATERIALS

Decision analytic model from the health care system perspective for 60-year-old patients with symptoms secondary to a suspected FTST tear was used to evaluate the incremental cost effectiveness of three imaging strategies over a two-year time-horizon: MRI, ultrasound, and ultrasound followed by MRI (US/MRI). Comprehensive literature search and expert opinion provided input data on cost, probability and utility estimates. The primary effectiveness outcome was quality-adjusted life years (QALYs) through 2-year follow up. Costs were estimated in 2016 U.S. dollars. Costs and health benefits were discounted at 3%.

RESULTS

Ultrasound was the least costly imaging strategy ($1385). MRI was the most effective (1.332 QALYs). Ultrasound was the most cost-effective imaging strategy, but was not dominant. Incremental cost-effectiveness ratio for MRI was $22,756/QALY gained, below the $100,000 willingness-to-pay threshold. Two-way sensitivity analysis demonstrated that MRI was favored over the other imaging strategies over a wide range of reasonable costs. In probabilistic sensitivity analysis, MRI was the preferred imaging strategy in 78% of the simulations.

CONCLUSION

MRI and ultrasound represent cost-effective imaging options to evaluate the patient suspected of a symptomatic FTST tear.

CLINICAL RELEVANCE/APPLICATION

Based on our results, MRI is the preferred strategy from the standpoint of cost effectiveness although the decision between MRI and US for a radiology department or group is likely dependent on additional factors, such as available resources and workflow.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
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SSE15

Science Session with Keynote: Musculoskeletal (Arthritis)

Monday, Nov. 27 3:00PM - 4:00PM Room: E451B

CT MR MK NM

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Andrew J. Grainger, MRCP, FRCR, Leeds, United Kingdom (*Moderator*) Nothing to Disclose
Arvin Kheterpal, MD, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSE15-01 Musculoskeletal Keynote Speaker: Update on Arthritis Imaging

Monday, Nov. 27 3:00PM - 3:10PM Room: E451B

Participants
Andrew J. Grainger, MRCP, FRCR, Leeds, United Kingdom (*Presenter*) Nothing to Disclose

SSE15-02 Integrated 18F PET/MRI for Assessment of Association of Inflammatory Activity in Psoriatic Arthritis and Vascular Calcification Metabolism

Monday, Nov. 27 3:10PM - 3:20PM Room: E451B

Participants
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PURPOSE

The study aimed to scrutinize the association between vascular calcification metabolism and musculoskeletal manifestations in patients with active psoriatic arthritis.

METHOD AND MATERIALS

In a prospective clinical trial 21 patients with psoriatic arthritis were included in the study. The participants were examined according to a standardized whole-body protocol on the PET/MRI-scanner Magnetom Biograph mMR (Siemens Healthcare, Germany) within a single session. Joint inflammation based on 18F-NaF PET/MRI images was assessed with respect to 8 different variables (SUVmax, tenosynovitis, bone and soft tissue oedema, bone erosions, joint-space narrowing, joint-subluxation, and interphalangeal ankylosis). Vascular calcification metabolism was evaluated based on 18F-NaF-PET/MRI images in terms of 18F-NaF-uptake in large (aorta ascendens, aortic arch, thoracal and abdominal aorta descendens) and medium vessels (supra-aortic arteries, arteria mesenterica superior, iliac arteries, arteria femoralis superficialis). SUVmax was normalized for the mediastinal blood pool. Furthermore, association with laboratory parameters (CRP, CCP, leukocytes, rheumatoid factor, triglycerides and cholesterol) was investigated.

RESULTS

A total of 21 subjects (71.4% men, 28.6% women, age range 23?-?97 years) were evaluated. Vascular calcification metabolism of large and medium vessels showed a significant positive correlation with changes observed in advanced stage of psoriatic joint manifestation ($p < 0.05$). Moreover, arthritic changes were not associated and showed no correlation with laboratory markers of inflammation ($p > 0.05$).

CONCLUSION

The severity of psoriatic joint manifestations in advanced stage of psoriatic arthritis does significantly correlate with vascular calcification metabolism. Patients with psoriatic arthritis showing mild clinical symptoms may present severe atherosclerotic changes. Both, psoriatic changes and vascular inflammation may precede the actual onset of clinical symptoms.

CLINICAL RELEVANCE/APPLICATION

Both, psoriatic joint changes and vascular inflammation may precede the actual onset of clinical symptoms. Integrated 18F-NaF-PET/MRI allows the detection and severity monitoring of vascular calcification metabolism in patients with psoriatic arthritis.

SSE15-03 Diffusion Weighted Imaging of the Sacroiliac Joints: Does It Improve Diagnosis of Inflammatory Sacroiliitis?

Monday, Nov. 27 3:20PM - 3:30PM Room: E451B

Participants
Luis S. Beltran, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

Determine if diffusion weighted imaging (DWI) improves diagnostic performance of conventional MRI in detection of sacroiliitis

METHOD AND MATERIALS

63 adult MRI studies of the sacroiliac joints (SIJ) including conventional MRI (STIR, T2FS, T1) and DWI were retrospectively collected into two versions: 1) MRI without DWI, and 2) MRI with DWI. Three musculoskeletal fellowship trained radiologists independently reviewed each version for bone marrow edema (BME) lesions around the SIJ as the test marker of sacroiliitis. DWI measurements were obtained using normalized ADCmean in BME lesions and normal appearing bone marrow around SIJ. Patient medical charts were reviewed using Assessment of SpondyloArthritis (ASAS) International Society criteria as the reference standard diagnosis of sacroiliitis. Diagnostic performance (accuracy, sensitivity, and specificity) of each version was compared based on combined data from all readers using generalized estimating equations. Kappa coefficient and McNemar test were used to compare inter-reader concordance rates. Mann-Whitney test was used to compare nADCmean values between patients with and without sacroiliitis based on reference standard ASAS criteria. ROC analysis was used to assess utility of nADCmean as a predictor of sacroiliitis.

RESULTS

29 patients with sacroilliitis and 34 patients without sacroiliitis were evaluated using ASAS criteria. Accuracy, sensitivity, and specificity of MRI without DWI was 65.1% (95% CI: 56.6-72.7), 65.5% (52.6-76.5), and 64.7% (53.3-74.7), and for MRI with DWI was 67.2% (57.7-75.5), 60.9% (45.8-74.2), and 72.5% (60.7-81.9), with no significant difference for all parameters (p>0.1). Kappa coefficient for MRI without DWI was 0.28 and for MRI with DWI was 0.46 (p=0.041). The mean nADCmean in patients without sacroiliitis was 2.01 (SD=4.05) and in patients with sacroiliitis was 2.91 (SD=3.14) (p=0.012). The nADCmean AUC was 0.697 (0.60-0.79). The nADCmean did not significantly improve ability to detect sacroiliitis relative to accuracy achieved using MRI without DWI alone (p=0.977).

CONCLUSION

Addition of DWI to conventional MRI does not significantly improve diagnostic performance in detection of inflammatory sacroiliitis.

CLINICAL RELEVANCE/APPLICATION

The potential utility of DWI for improving detection of sacroiliitis is currently of great interest. However, based on our data, we cannot recommend adding DWI to routine MRI of the sacroiliac joints.

SSE15-04 Postpartum Changes in the Sacroiliac Joints May Mimic Sacroiliitis of Axial Spondyloarthritis on MR Imaging

Monday, Nov. 27 3:30PM - 3:40PM Room: E451B

Participants
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PURPOSE

To compare bone marrow edema (BME) on MRI in the sacroiliac joints of women in the early postpartum period with women suffering from axial spondyloarthritis.

METHOD AND MATERIALS

This multicenter study was IRB-approved and informed consent was obtained from all participants. We prospectively acquired MR images of the sacroiliac joints of healthy postpartum women within three days after giving birth. We retrospectively acquired an age- and gender-matched control group of patients with known axial spondyloarthritis (based on diagnostic codes in our university hospital database) and used the initial MR scan of these patients in our PACS (i.e. before consecutive treatment). All MR scans comprised a coronal oblique STIR sequence of the sacroiliac joints. We assessed all MR images according to the Assessment of SpondyloArthritis international Society (ASAS) criteria for the presence of BME, and compared between the postpartum and spondyloarthritis group (Chi-square test). In a subgroup analysis, we compared BME between vaginal deliveries and cesarean sections (Chi-square test).

RESULTS

Thirty women were imaged postpartum (mean (±standard deviation) age 33±5 years, 17 vaginal deliveries, 13 cesarean sections, after 39±1 weeks of gestation, baby weight 3270±503g), and 30 women with axial spondyloarthritis (36±5 years). MRI was positive (based on ASAS-criteria) for axial spondyloarthritis in 19/30 (63.3%) of postpartum women and in 22/30 (73.3%) of women with

axial spondyloarthritis without a statistically significant difference (P=.579). Lumbar back pain at the time of MRI was present in 10/30 (33%) of postpartum women. Of those, 6/10 (60%) showed positive MRI for axial spondyloarthritis. In postpartum women without lumbar back pain, 13/20 (68.4%) showed positive MRI for axial spondyloarthritis. BME was present in 8/17 (47.1%) women with vaginal deliveries and in 8/13 (61.5%) of women with cesarean sections (P=.676).

CONCLUSION

Postpartum women may show similar bone marrow changes in the sacroiliac joints on MR imaging as patients with axial spondyloarthritis.

CLINICAL RELEVANCE/APPLICATION

Pregnancy induced BME in the sacroiliac joints may mimic sacroiliitis of axial spondyloarthritis on MRI. Caution is warranted not to overcall all BME as sacroiliitis of axial spondyloarthritis.

SSE15-05 The Significance of Subchondral Sclerosis at the Sacroiliac Joints in the Diagnosis of Inflammatory Sacroiliitis

Monday, Nov. 27 3:40PM - 3:50PM Room: E451B

Participants
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PURPOSE

To determine whether subchondral bone sclerosis is a specific finding for the CT diagnosis of sacroiliitis.

METHOD AND MATERIALS

CT scans of 215 patients with low back pain were retrospectively reviewed, comprising 107 with clinically proven spondyloarthritis (SpA) and a control group of 108 age and gender matched subjects. Three blinded musculoskeletal radiologists received formal training and scored the CT scans for diagnosis and the features of sacroiliitis. Sclerosis was specifically defined and scored if located along the cartilaginous compartment, measuring more than 5mm in all 3 planes and present more than 5mm from the joint perimeter. Discrepant scores were arbitrated by majority and reader correlation calculated using ICC statistics. Sclerosis was compared with clinical diagnosis and using statistical logistic regression, the relationship was determined by calculating sensitivity and specificity for each variable using 95% confidence intervals (CI).

RESULTS

The cohort comprised 140 males and 75 females, with a mean age of 45. For any single articular surface, the specificity range of subchondral sclerosis for sacroiliitis was between 84% (CI 79-89%) and 94% (CI 91-97%), and for any two articular surfaces 94 (CI 91-97) to 97% (CI 95-100). If all four articular surfaces were affected, specificity was 99% (CI 98-100%). Sensitivity ranged from 14% for all four articular surfaces, to 55% for either ilium. The inter-observer correlation for the three readers was substantial and, calculated individually for each articular surface, ranged between 0.65-0.76. Subchondral erosion had comparable specificity range 90-100% (CI 85-100% depending on number of surfaces affected), and ICC range 0.71-0.78.

CONCLUSION

When subchondral bone sclerosis measures more than 5mm in three planes and is located more than 5mm from a joint perimeter, it has high specificity for sacroiliitis, regardless of how many articular surfaces are involved, with comparable specificity and reader correlation to erosion.

CLINICAL RELEVANCE/APPLICATION

When subchondral bone sclerosis satisfies location and minimum size criterion, it is specific for inflammatory sacroiliitis. Understanding the application of these location and size criteria is important to Reporting Radiologists analyzing radiological imaging for sacroiliitis.

SSE15-06 Evaluation of Bone Erosions in Rheumatoid Arthritis Patients using CBCT and MRI

Monday, Nov. 27 3:50PM - 4:00PM Room: E451B

Participants
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PURPOSE

This study assessed the utility of a novel cone beam CT (CBCT) extremity scanner for evaluation of radiological signs of rheumatoid

This study, assessed the utility of a novel cone beam CT (CBCT) extremity scanner for evaluation of radiological signs of rheumatoid arthritis (RA), such as bone erosions in wrist and metacarpophalangeal (MCP) joints. For this purpose, we compared the bone erosion scores for CBCT and MRI in RA patients along with test-retest reproducibility of the CBCT data.

METHOD AND MATERIALS

In this IRB approved study, informed consent was obtained from 10 patients (5 males, 5 females; mean age 58 years, age range 34 - 81 years) who had clinically confirmed diagnosis of RA. All patients underwent 1 MRI scan and 1 CBCT scan of the wrist and hand followed by a second CBCT scan one week later. The field of view for all scans extended from the distal radioulnar joint to the phalanges. The MRI was done on a 3T clinical MR scanner with dedicated hand coil, while the CBCT was done using a prototype CBCT extremity scanner. A radiologist with 7 years of musculoskeletal imaging evaluated all images for bone erosions in MCPs, carpal bones and distal radius and ulna, using RAMRIS like scoring between 1 to 10 (1 is 0-10% erosion, 2 is 11-20% erosion etc). Repeatability and agreement of both methods were evaluated with Intraclass Correlation Coefficients (ICC) and Bland-Altman plots.

RESULTS

Bland-Altman analysis showed agreement of 0.007±3.5, 3.5 to -3.5 (bias ± repeatability coefficient, 95% limits of agreement interval) with ICC score of 0.65 showing moderate correlation between MRI and CBCT bone erosion scores. Correlation was higher for bone erosion scores of MCPs than for wrist joints. Test-retest reproducibility for the CBCT scans showed agreement of 0.03±1.13, 1.17 to -1.10 with an excellent ICC score of 0.95.

CONCLUSION

Moderate correlation for bone erosion scores between MRI and CBCT can be attributed to higher spatial resolution of CBCT, while the prototype extremity CBCT images showed high test-retest reproducibility. Further analysis of image data for bone edema and synovitis will provide additional validation of utility for CBCT extremity systems.

CLINICAL RELEVANCE/APPLICATION

The prototype CBCT extremity scanner may, after further validation in longitudinal studies, become a useful tool for detection of RA diagnostic evaluation.

SSE16

Nuclear Medicine (Neurodegenerative Disease Imaging)

Monday, Nov. 27 3:00PM - 4:00PM Room: S505AB

BQ CT MR NR NM

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Phillip J. Koo, MD, Phoenix, AZ (*Moderator*) Advisory Board, Bayer AG; Advisory Board, Johnson & Johnson; ; ;
Amir H. Khandani, MD, Chapel Hill, NC (*Moderator*) Consultant, Progenics Pharmaceuticals, Inc; Consultant, WorldCare International, Inc; Consultant, F. Hoffmann-La Roche Ltd;

Sub-Events

SSE16-01 Parallel Artificial Intelligence (AI) to Simulate Human Consensus Reading of Amyloid PET in Alzheimer's Disease (AD)

Monday, Nov. 27 3:00PM - 3:10PM Room: S505AB

Participants
Satoshi Minoshima, MD, PhD, Salt Lake City, UT (*Presenter*) Research Consultant, Hamamatsu Photonics KK; Research Grant, Hitachi, Ltd; Research Grant, Nihon Medi-Physics Co, Ltd;
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PURPOSE

This study is to develop and evaluate a parallel AI system to simulate human consensus reading of amyloid PET scans and to improve AI interpretation of imaging data in dementia.

METHOD AND MATERIALS

Parallel AI architecture was realized using 'U Health Vivian' AI Framework (University of Utah) in which 3 multi-layer perceptron (MLP) AI cores were adjudicated by a concurrent MLP AI to simulate human consensus reading. 3D-SSP extracted regional values from [F-18]florbetapir PET data (165 normals, age 75±6.9 yrs, 78 female and 148 AD patients, age 75±8.2 yrs, 62 female, normalized to the cerebellum) were used for testing. Each AI core was trained independently via randomization and bootstrap with 1) a different number of scans (50% and 100% of total cases) and 2) an unequal case mix of positive and negative scans (one-third positives vs negatives) to simulate heterogeneity in the human observer experience. The discriminatory accuracy by the Parallel AI was compared to that by the conventional SUVr analysis.

RESULTS

Each AI core achieved the average discriminatory accuracy of 84% by training with an unequal case mix; 88% with a smaller number of balanced cases; and 90% with a larger number of balanced cases. Smaller numbers of the training data sets and an unbalanced case mix resulted in larger variances and lower accuracy (79%-88%, $p<0.05$ compared to the larger balanced cases). The parallel AI with a concurrent AI consistently improved the accuracy of individual AI cores from 84% to 89% for the unbalanced case mix and 88% to 89% for a smaller number of balanced cases while the accuracy with a larger number of balanced cases remained same at 90%. The Parallel AI performed equal to or better than the discrimination using the conventional SUVr (88% accuracy at SUVr threshold of 1.35).

CONCLUSION

This study demonstrates that a Parallel AI might be a novel approach to improve AI-based interpretation of amyloid PET scans, similar to the improvement typically seen by human consensus reading, especially when the training data set is limited and heterogeneous. Further investigation is warranted to test various configurations of the parallel AI system.

CLINICAL RELEVANCE/APPLICATION

AI is potentially a powerful way to support radiologist's work and improve consistency and accuracy of image interpretation. Unique AI technologies and applications will need to be explored further.

SSE16-02 PET Image Classification in Dementia: Comparison of a Deep Learning Algorithm to Standard Clinical Methods and Patient Follow-Up

Monday, Nov. 27 3:10PM - 3:20PM Room: S505AB

Participants
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PURPOSE

Deep learning has the potential to improve accuracy of diagnosis among patients presenting with symptoms of dementia, which could influence treatment decisions affecting this population. We describe the training and validation of a deep learning model to classification of FDG PET images from the Alzheimer's Disease Neuroimaging Initiative ADNI dataset, and the generalization of the model to a clinical dataset.

METHOD AND MATERIALS

~3500 FDG PET exams were downloaded from (ADNI) and ~50 FDG Neuro PET exams were obtained from PACS. Metadata was used to assign a diagnosis (Dx) of Normal (NL), Mild Cognitive Impairment (MCI), or Alzheimer's disease (AD) to each exam. UCSF images were labeled using Radiology reports to assign a Dx at the time of imaging, and chart review to assign a final Dx. All images were resampled to 2 mm isotropic voxels and cropped to a 20 x 20 x 18 cm3 region centered on the brain. A set of axial slices spanning the mid-cerebellar region to just inferior to the skull apex was determined, and slices were arranged into a 4 x 4 grid. Each grid was converted to PNG format and RGB channels were used to spatially encode the slices such that homologous slices were assigned the same color. ADNI subjects were divided into a training and validation set. An off-the-shelf deep learning model with ImageNet trained weights was implemented in Python using the Keras library and fine-tuned using the ADNI training set. The model was applied to the ADNI validation set and to the UCSF data. ROCs and AUCs were computed.

RESULTS

AUCs predicted by the model for the AD category were 0.89, 0.97, and 0.99 for the ADNI validation, UCSF Folow-up labeled and UCSF Rad-report labeled sets, respectively AUCs predicted by the model for the MCI category were 0.69, 0.64, and 0.51. AUCs predicted by the model for the NL category were 0.81, 0.78, and 0.82.

CONCLUSION

Deep learning may be an effective tool in AD diagnosis, however training and validation with larger data sets is required.

CLINICAL RELEVANCE/APPLICATION

Although qualitative interpretation by an expert is the most accurate method, other interpretive aids have been shown to be helpful to those who are less experienced with 18F-FDG PET. Deep learning models could support management of patients presenting with symptoms of dementia.

SSE16-03 Regional Brain Uptake Variations in Alzheimer's disease, Mild Cognitive Impairment and Normal Controls: 18F-FDG vs 18F-Florbetapir (Amyvid)

Monday, Nov. 27 3:20PM - 3:30PM Room: S505AB

Participants
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PURPOSE

Brain discrepant distribution patterns of amyloid radiotracers compared with that of FDG in subjects with different levels of dementia has long been a source of debate. This study aims to measure the uptake of two tracers in various brain regions and to compare how 18F-florbetapir (Amyvid) and 18F-FDG regional uptake values vary from Normal Controls (NC) to Mild Cognitive Impairment (MCI) and Alzheimer's disease (AD).

METHOD AND MATERIALS

19 patients with a clinical diagnosis of AD, 23 with MCI and 21 elderly controls underwent PET/CT imaging with Amyvid and FDG. Regional brain uptakes were measured by manual delineation of ROIs on PET/CT fused image slices around Frontal (F), Temporal (T), and Prieto-Occipital (PO) regions, and cerebellum based on predefined anatomical Criteria. Average global glucose metabolism and average global amyloid burden were calculated by generating mean standardized uptake values (GSUVmean). Values were then normalized to cerebellum by developing GSUVmean ratios.

RESULTS

The highest SUVmean ratio for FDG was noted in the F region followed by PO and T regions. In NC group, the PO region had the highest uptake ratio followed by F and T regions. However, in MCI and AD groups, decreased PO ratios were observed and were followed by those of T region, while F region had the highest ratio. In NC and MCI groups, T region ratio was significantly lower than those of F and PO ($P<0.001$), but in the AD group, this difference was not statistically significant. In either MCI or AD groups, F, PO and T ratios were significantly decreased compared to the NC group.($P<0.001$) Amyloid imaging showed the highest SUVmean ratios in the F region followed by those of PO and T regions. This pattern was the same in NC, MCI and AD Group independently. As a whole, F ratios were the highest among the values measured. In spite of increased ratios in regions examined in MCI and AD, the differences were not statistically significant.

CONCLUSION

FDG images indicated major hypo-metabolism in the PO region as the disease converts from MCI to AD. While Amyvid shows the highest amyloid burden and the highest uptake rise in the F region which is not supported by histopathological findings and suggests a substantial contribution of non-specific binding.

CLINICAL RELEVANCE/APPLICATION

FDG accurately differentiates between NC and MCI and AD and appears to be more applicable and reliable method for assessing patients with Alzheimer's disease.

SSE16-04 Plasma Glucose Effect upon Regional Brain FDG Uptake: Implications for Semi-Quantitative Image Analysis and Dementia Classification

Monday, Nov. 27 3:30PM - 3:40PM Room: S505AB

Participants
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PURPOSE

We recently demonstrated that plasma glucose level can affect FDG uptake in the brain and basal ganglia. Additionally, prior studies have also suggested that plasma glucose, above or below 125 mg/dl could change the regional cerebral pattern of FDG uptake and thus may affect clinical interpretation. This current study attempted to look at the plasma glucose effect as a continuum on regional cerebral FDG uptake.

METHOD AND MATERIALS

We used our prior dataset of 436 scans from 229 patients was used to act as a comparison population. 100 consecutive patients scanned for tumor evaluation were obtained. Patient were excluded if they had history of dementia, CVA, prior treatment (chemotherapy or XRT), known structural brain lesion, or high tumor burden. This latter has been shown to affect brain FDG uptake (see separate abstract). Brain PET images were reformatted and analyzed by Scenium (Siemens Biograph T6; Siemens Medical Solutions, Hoffman Estates, IL, USA). The mean SUV from the different cortical brain regions were compared to the basal ganglia measurements using four different methods: absolute difference, normalized (to blood pool) absolute difference, population average absolute difference and normalized (to blood pool) population absolute difference. Additionally, Z-scores for these different regions were also looked at, using the internal Scenium database. These 4 "differences" and the Z-score were then plotted as a function of plasma glucose level; residual analysis and/or subsequent linear regression were performed. A region was deemed significantly different if the slope of this linear regression was significant ($p<0.05$).

RESULTS

We were able to confirm our previous finding that diffuse brain uptake decreases with increasing plasma glucose. However, we noted also regional cerebral differences, in particular the mesiotemporal lobes and cerebelli.

CONCLUSION

Variation in plasma glucose affects FDG uptake in brain regions differentially, in particular the mesiotemporal lobes and cerebelli.

CLINICAL RELEVANCE/APPLICATION

These findings may impact imaged based dementia classification, choice of normalization technique when analyzing brain PETs, and/or suggest a need in developing a normalized database that corrects for plasma glucose

SSE16-05 The Impact of Total Counts on Iodine-123 Ioflupane SPECT Quantification

Monday, Nov. 27 3:40PM - 3:50PM Room: S505AB

Participants
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PURPOSE

I-123 Ioflupane SPECT can be used to quantify the concentration of regional cerebral dopamine transporters (DAT) in patients with movement disorders to differentiate normal and abnormal states. The objective of this RSNA Quantitative Imaging Biomarker Alliance sponsored study is to determine the total counts needed for accurate and precise estimation of the striatal specific binding ratio

(SBR).

METHOD AND MATERIALS

An I-123 striatal phantom with SBRs of 4:1 and 2:1, which represent realistic uptake patterns of normal and abnormal distribution, was imaged on SPECT/CT with clinical acquisition parameters and 12 million total counts. Poisson resampling was implemented on Matlab to simulate 5 noise realizations corresponding to each of 4 reduced count levels of 3, 2, 1 and 0,5 million counts. Each data set was reconstructed with FBP, OSEM, and OSEM with resolution recovery and correction for attenuation and scatter. OSEM parameters included 12 iterations, 8 subsets and a Gaussian filter. Striatal compartments and background were defined on CT and applied to SPECT to determine mean counts. A generalized linear model was used to test the null hypothesis that the bias and precision of SBR measurements do not change when count levels of 0.5, 1, 2 million are compared to 3 million.

RESULTS

As expected, due to partial volume effects, the SBR was substantially underestimated in all cases. However, compared to the 3 million count level the 2 and 1 million levels resulted in similar bias and variance and only the 0.5 million level resulted in a statistically significant increase in bias and variance. This was consistent across brain regions and reconstruction methods, except for the left caudate where an increase in variance was not detected. For the 3, 2, 1, and 0.5 million levels the mean bias in measured SBR was 2.26, 2.29, 2.27 and 2.52, respectively, while the mean variance was 0.0069, 0.0056, 0.0057 and 0.0147, respectively.

CONCLUSION

The data suggests that apart from the 0.5 million level the bias and precision of measured SBR are similar for evaluated count levels, hence a count level down to 1 million can be used to quantify DAT with reduced acquisition time or radiation exposure.

CLINICAL RELEVANCE/APPLICATION

Guideline in USA and Europe recommend > 1.5 and > 3 million counts for I-123 Ioflupane SPECT. Low count acquisitions without compromising imaging objectives allows reducing patient discomfort and/or radiation exposure.

SSE16-06 Evaluation of the PET Performance of Hybrid PET/MRI Compared to PET/CT in Non-Lesional Epilepsy

Monday, Nov. 27 3:50PM - 4:00PM Room: S505AB

Participants
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PURPOSE

PET/MRI can provide greater rates of lesion localization in patients with medically refractory epilepsy (MRE). However, the use of PET/MRI can be limited by MRI based attenuation correction (MRAC), where inaccurate estimation of AC may lead to erroneous estimation of PET activity. Recent advances in MR image processing have improved the performance of MRAC for PET/MR neuroimaging. This paper compares a novel MRAC approach to CT based attenuation correction (CTAC) - the current clinical standard, in patients with MRE.

METHOD AND MATERIALS

PET/MRI was acquired simultaneously in 15 patients with MRE on a hybrid system (Siemens Healthcare, Erlangen, Germany) immediately after a clinical PET/CT scan. PET/MRI data were corrected for attenuation using CT (PET-MRI-CTAC) and RESOLUTE MRAC method (PET-MRI-MRAC). PET images were compared through visual rating of metabolic activity in the frontal, temporal, parietal, occipital lobes and cerebellum and augmented by quantitative comparison of each patient's PET scan to controls (MI Neurology, Siemens Medical Solutions, USA). The mean relative difference (RD) between the two PET images was calculated for whole brain and in selected brain regions. PET/MRI performance was further evaluated using Pearson correlation to compare regional mean SUV and z-scores between PET AC methods.

RESULTS

The global RD between PET-MRAC and PET-CTAC activity was (mean ± SD%) -4.66 ± 1.93%, while regional RD ranged from -4.71 to -3.65%. A strong correlation between PET AC methods was seen across brain regions (range $r2 = 0.79$ to 0.98, $p<0.0001$) and in particular the mesial temporal lobe ($r2 = 0.98$, $p<0.0001$), an area commonly associated with MRE. Visual assessments between PET/MRI and clinical PET/CT were matched in all but 3 patients, where PET/MRI revealed mild abnormalities not reported on PET/CT.

CONCLUSION

Similar PET performance was observed between AC methods highlighting the feasibility of PET/MRI imaging in epilepsy. Further clinical evaluation using multiple raters is ongoing as well as evaluation of PET/MRI diagnostic accuracy compared to reference standards (histology and seizure-free outcomes).

CLINICAL RELEVANCE/APPLICATION

PET/MRI is emerging as a powerful tool for detecting abnormalities in epilepsy. Wider clinical adoption would occur if diagnostic equivalence to current clinical standard (PET/CT) is demonstrated.

SSE17

Neuroradiology (Dementia Imaging: Looking Through the Fog)

Monday, Nov. 27 3:00PM - 4:00PM Room: N227B

NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Kei Yamada, MD, Kyoto, Japan (*Moderator*) Nothing to Disclose
Claudia D. Leite, MD, PhD, Sao Paulo, Brazil (*Moderator*) Nothing to Disclose

Sub-Events

SSE17-01 Evaluation Changes of Cerebral Iron Deposition in Patients with Alzheimer's disease and Mild Cognitive Impairment using SWI Phase Data

Monday, Nov. 27 3:00PM - 3:10PM Room: N227B

Participants
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PURPOSE

Based on voxel-based method, susceptibility weighted imaging (SWI) phase value was used to investigate the changes of iron deposition in Alzheimer's disease (AD) and Mild Cognitive Impairment (MCI) patients.

METHOD AND MATERIALS

24 AD patients, 22 MCI patients and 20 no cognitive impairment (NCI) cases were investigated (Table 1). For all cases, SWI scanning was conducted with phase images acquired on a SIEMENS Trio 3T scanner. The acquisition parameters were: slice per slab = 80, TR/TE = 27/20 ms, voxel size = 0.9X0.9X1.5 mm3. High-resolution T1 MPRAGE images were acquired as well. After image acquisition, phase maps were calculated using in-house software. T1 MPRAGE was segmented using SPM8 and registered onto phase maps. Gray matter (GM) phase value of whole brain was calculated for each case. Preprocessing and statistical analyses were performed on SPM8.

RESULTS

Among the three groups, the Phase value was different significantly ($p < 0.005$, $F=7.64$, uncorrected for multiple comparisons) in right hippocampus, right amygdale, right middle, right caudate and bilateral putamen and insula (figure). The phase value difference was significant between MCI and NCI ($p < 0.005$, $T=3.18$, uncorrected for multiple comparisons) in right superior temporal gyrus and middle temporal gyrus. The phase value difference was significant between AD and NCI ($p < 0.005$, $T=4.20$, uncorrected for multiple comparisons) in right hippocampus, right amygdale, right superior temporal gyrus, right middle temporal gyrus and bilateral putamen and insula.

CONCLUSION

Our results revealed patterns of regional iron deposit of AD and MCI patients, suggesting underlying iron metabolism abnormality. As a potential biomarker, Phase value is effective to measure regional iron deposit changes in AD and MCI patients.

CLINICAL RELEVANCE/APPLICATION

SWI is a useful noninvasive MRI sequence to identify the cerebral iron deposit in Alzheimer's disease and MCI patients.

SSE17-02 Imaging Alzheimer Disease Plaques Using Small-Angle X-ray Scattering

Monday, Nov. 27 3:10PM - 3:20PM Room: N227B

Participants
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PURPOSE

Beta-amyloid plaques have been shown to play a role in the development of Alzheimer's (AD), a neurodegenerative disease characterized by impaired memory, reduce cognitive skills, and diminished ability to perform everyday tasks for which there is currently no cure or effective treatment. Optical imaging has been shown to characterize molecular AD hallmarks but lacks the ability to image deep tissue. On the other hand, PET imaging is widely used to locate beta-amyloid plaques in the brain but suffers from low spatial resolution and low specificity. We report on small-angle x-ray scattering (SAXS) computed tomography for detecting amyloid plaques for Alzheimer's disease in vivo with higher resolution than PET. Analysis of physical phantoms and mouse brain measurements along with computational simulations of x-ray transport are reported to explore this technique.

METHOD AND MATERIALS

SAXS can characterize and selectively image structures based on electron density maps without any exogenous contrast agent. We describe phantoms for demonstrating planar SAXS imaging with improved contrast of molecular targets. We measured normal and transgenic Alzheimer's disease mouse model brains using planar SAXS to assess normal and disease patterns. We perform simulations using a publicly available, GPU-accelerated, Monte Carlo radiation transport tool to assess feasibility and optimization of SAXS imaging for detecting amyloid plaque in mice and humans in vivo reporting radiation dose and SNR estimates.

RESULTS

We were able to detect a bovine serum albumin (BSA) fibril amyloid model target placed on top of a slice of wild-type mouse brain at q angles lower than 0.5 nm-1. The target shows higher intensity than normal brain tissues. Peaks belonging to myelin in the corpus callosum region were visible at 1 and 1.6 nm-1. SAXS imaging simulations with 16-, 20-, and 33-keV x rays were performed on a voxelized DIGIMOUSE digital phantom with embedded targets of 0.1, 0.4, and 0.6 mm in diameter showing that 33-keV x rays achieve significant contrast in a mouse head approximately 1.5x1.5 cm2 in size.

CONCLUSION

The findings of the study indicate that amyloid plaque imaging is feasible using SAXS-CT.

CLINICAL RELEVANCE/APPLICATION

Our study contributes to assessing feasibility and providing the computational and experimental tools needed for the design and optimization of SAXS imaging to measure AD biomarkers *in vivo*.

SSE17-03 Cerebral Perfusion Changes after Acetyl-1-Carnitine Treatment in Early Alzheimer's Disease: A Single Photon Emission Tomography Study

Monday, Nov. 27 3:20PM - 3:30PM Room: N227B

Participants
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PURPOSE

Although beneficial effects of acetyl-L-carnitine (ALC) in Alzheimer's disease (AD) have been reported, underlying neural correlates remain unclear. The current study aimed to investigate cerebral perfusion changes after ALC treatment in AD patients using technetium-99m hexamethylpropylene amine oxime single photon emission computed tomography (SPECT).

METHOD AND MATERIALS

A total of 18 patients with early AD were recruited and assessed with brain SPECT, Mini-Mental State Examination (MMSE), Clinical Dementia Rating (CDR), Global Deterioration Scale (GDS), and Neuropsychiatric Inventory (NPI). Changes in brain perfusion, severity of dementia, cognitive performance, and neuropsychiatric disturbances after ALC administration were examined.

RESULTS

After approximately 1.4 years of ALC administration, changes in the scores of MMSE, CDR, GDS, and NPI were not significant. Voxel-wise whole-brain image analysis revealed that increased perfusion was found in the right precuneus ($p < 0.001$) whereas perfusion reductions were detected in the left inferior temporal gyrus ($p < 0.001$), right middle frontal gyrus ($p < 0.001$), and right insular cortex ($p = 0.001$) at the follow-up.

CONCLUSION

Our findings suggest that ALC-induced perfusion increase in the precuneus may attenuate progressive deterioration of cognitive function and neuropsychiatric symptoms.

CLINICAL RELEVANCE/APPLICATION

This is the first SPECT study that examined cerebral perfusion changes associated with ALC administration in early AD patients. After 1.4 years of ALC administration, cognitive performances, severity of dementia, and levels of neuropsychiatric symptoms were not significantly changed, whereas rCBF in the precuneus increased. Our findings suggest that ALC-induced rCBF increase in the precuneus may attenuate progressive deterioration of cognitive function and neuropsychiatric disturbances.

SSE17-04 The Association between CD33 Gene and Cognitive Impairment in Alzheimer's Disease Spectrum: Functional Connectivity Density as Mediator and Moderator

Monday, Nov. 27 3:30PM - 3:40PM Room: N227B

Participants
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PURPOSE

The object of this study is to explore the role of CD33 gene in the brain function and its relationship with cognitive function in Alzheimer's disease (AD) spectrum patietns by using resting-state functional magnetic resonance imaging (R-fMRI).

METHOD AND MATERIALS

One hundred and eighty-nine AD spectrum participants were selected form ADNI database. All subjects completed R-fMRI scan, CD33 (rs3865444) gene detection and cognitive function assessment (ADAS-Cog score). The brain function was assessed using a voxel-based analysis of global functional connectivity density (gFCD) using R-fMRI data. 3 × 2 analysis of covariance was employed to conduct the main and interactive effect of disease and CD33 genotype. Further, conditional process analysis was used to investigate mediated and moderated effects of brain function on the relationship between CD33 and cognitive function.

RESULTS

The main effect of the disease showed that in the default mode network, the gFCDs in AD group were significantly higher than that of MCI and CN group, but no significant difference between CN and MCI group. The main effect of CD33 genotype was found in dorsal anterior cingulate cortex (dACC) and right caudate nucleus. The interactive effect of disease and CD33 was located in the right parahippocampal gyrus, specially, the gFCD in the rs3865444 A+ group is higher than rs3865444 CC group in the stage of CN, while lower in the stage of MCI but no difference in the stage of AD. The gFCDs in DMN and dACC were positively correlated with cognitive function among AD spectrum patients. The conditional process analysis revealed that the gFCD in precuneus is a moderator, while gFCD in dACC is a mediator for the relationship between CD33 genotype and cognitive function among all participants. Interesting, the mediated effect of dACC was moderated by the gFCD in precuneus. Further subgroup analysis showed that the mediated and moderated effects also occurred in the MCI subgroup.

CONCLUSION

During the progression of AD, CD33 gene polymorphism presents an inverse effect between the stage of CN and MCI, but equally in the stage of AD. The gFCD played as moderator and mediator for the association between CD33 genotype and cognitive performance in AD spectrum patients.

CLINICAL RELEVANCE/APPLICATION

The brain functional features may confer vulnerability to cognitive impairment between AD spectrum patients with different CD33 genotype.

SSE17-05 Multi-Scale Full-Organ to Intra-Cellular 3D Detection of Alzheimer's disease Neurodegeneration via X-Ray Phase Contrast CT

Monday, Nov. 27 3:40PM - 3:50PM Room: N227B

Participants
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PURPOSE

Full-organ MRI-based imaging of Alzheimer's Disease (AD) lacks the spatial resolution necessary to discriminate nervous tissue complexity at the cellular level. Other pre-clinical techniques for imaging neuronal populations, such as deep two-photon calcium imaging, 3D light microscopy or tissue-cleared full-organ fluorescence microscopy are also limited, respectively by the spatial restriction of neuronal staining with calcium indicator dyes, the size of dissected sample sections, or by an only partial labelling of cell populations. X-ray Phase Contrast CT (PCI-CT) provides soft-tissue sensitivity without any application of stains, labels or contrast agents. Most interestingly, PCI can visualize nervous tissue structure at multiple scales, from full-organ anatomy to single cells without the need for sample dissection. We thus choose PCI-CT for a unique analysis of AD pathology in the brain of 3xTgAD mice expressing three mutant alleles Psen1, APP and tau, which display both amyloid-ß plaque and tangle pathology and represent an experimental model of AD.

METHOD AND MATERIALS

Multi-scale 3D images of brain samples from wild-type mice (n=6) and 3xTgAD mice (n=6, all at 13 months of age), were obtained by synchrotron PCI-CT. We used 30 keV X-rays, a sCMOS-sensor PCO camera, and switched between optics systems with voxel sizes from 3^3 µm³ to 0.3^3 µm³.

RESULTS

Full-organ 3-micron brain CTs showed PCI's sensitivity to microscopic deposits within both hippocampal and cortical cell layers which suggest protein aggregation. Moreover, localized 0.3 µm CTs detected single neuronal cells, intra-neuronal aggregates, and extracellular deposits. We observed both healthy and altered pyramidal neurons and recognized them alongside agglomerates. Image contrast allowed quantification of aggregate load and of cell-layers-specific plaque-size 3D distributions. Sub-cellular structures (conic-shaped somas, circular high-density nuclei) were also visible at this resolution.

CONCLUSION

PCI-CT detects aggregates resembling amyloid plaques in different brain regions and provides unique 3D mappings of neuronal tissues, their surrounding angio-structures, and of single neurons, in aged healthy and diseased 3xTgAD mice.

CLINICAL RELEVANCE/APPLICATION

PCI-CT opens a fascinating novel avenue for post-mortem imaging of neurodegenerative diseases. It provides a full-organ virtual histology, which shows local 3D cellular anatomy and pathology.

SSE17-06 Classification of Alzheimer's Disease by Compartmental Sparse Feature Selection in Structural MRI Data

Monday, Nov. 27 3:50PM - 4:00PM Room: N227B

Participants
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PURPOSE

A compartmental sparse feature selection method was used for identification of Alzheimer's Disease from the healthy and compared with voxel-based morphometry method.

METHOD AND MATERIALS

64 Alzheimer's disease(AD) patients and 60 healthy control cases(HC) were investigated(Table 1). For all cases, high-resolution T1 MPRAGE images were acquired on a SIEMENS Trio 3T scanner. The acquisition parameters were: TR/TE=2530/3.44ms, voxel size=1X1X1mm3. Depending on prior knowledge, the whole gray matter and 10 ROIs (bilateral amygdala(AMYG),hippocampus(HIP),parahippocampal gyrus(PHG),cuneus(CUN),cingulate gyrus(CG),parietal gyrus(PG), precuneus(PCUN), frontal gyrus(FG), temporal gyrus(TG) and amygdala+hippocumpus+parahippocampal gyrus(AHP)) were selected according to AAL template. The proposed method partitioned the normalized 3D T1-weighted gray matter images into several compartments. It performs feature selection and classification compartmentally according to the local feature dimension estimation and local feature selection using sparse principal component analysis(SPCA) method followed with elastic-net logistic regression(ENLR) classifier. Voxel-based morphmetry(VBM) method was used and the same normalized T1-weighted gray matter data were statistically analyzed on SPM8 by two-sample t-test for comparing AD with HC.

RESULTS

The classification accuracy of all gray matter and 10 ROIs are as follow (Figure1). Accuracy of all gray matter, AMYG, HIP, PHG, CUN, CG, PG, PCUN, FG, TG and AHP is 0.78, 0.76, 0.68, 0.73, 0.60, 0.63, 0.69, 0.67, 0.65 and 0.83 respectively. Cortical volumes decreased significantly($p<0.001$, $t=3.82$) in AD compared to HC in bilateral hippocampi, amygdalae, superior temporal pole, left parahippocampal gyrus, left inferior temporal cortex (Figure 2).

CONCLUSION

Our results revealed high classification accuracy for AD diagnosis by using compartmental sparse feature selection method and the accuracy of ROIs was consistent with results of classic VBM method.

CLINICAL RELEVANCE/APPLICATION

Compartmental sparse feature selection is an effective computer-aided diagnosis method to help clinician to identify AD.

SSE18

Neuroradiology (Spine Imaging: Backbone of Neuroradiology?)

Monday, Nov. 27 3:00PM - 4:00PM Room: N229

MR NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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John L. Go, MD, Los Angeles, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSE18-01 Biochemical Intervertebral Disc Alterations in Patients with Low Back Pain and Radiculopathy

Monday, Nov. 27 3:00PM - 3:10PM Room: N229

Participants
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PURPOSE

To assess the glycosaminoglycan (GAG) content of lumbar intervertebral discs (IVD) in patients with low back pain (LBP) and radiculopathy using glycosaminoglycan chemical exchange saturation transfer imaging (gagCEST).

METHOD AND MATERIALS

258 lumbar IVDs of 53 participants, 21 healthy volunteers, 19 patients with LBP and 13 patients with radiculopathy (28 female; 25 male; mean age: 45.5 ± 16.7 years; range: 23 - 83 years), were examined with a 3T MRI scanner. Biochemical gagCEST imaging was used to determine the GAG content of each nucleus pulposus (NP) and annulus fibrosus (AF).

RESULTS

Significantly reduced gagCEST values of NP were found in patients with LBP and/or radiculopathy ($p < 0.0001$) compared to healthy control group. NP gagCEST values were significantly lower in patients with LBP ($p < 0.0001$) and radiculopathy ($p = 0.0005$) compared to healthy volunteers, respectively. We saw an association between pain and GAG loss with significantly lower gagCEST values in participants with dorsal pain at examination day ($p = 0.0004$) and higher pain scores ($p < 0.0001$) compared to participants without LBP. Participants with body mass index >= 25 revealed lower gagCEST values compared to participants with BMI < 25 ($p = 0.02$).

CONCLUSION

GagCEST analysis indicated significantly lower GAG values of NP in patients with LBP or radiculopathy, in participants with elevated BMI, current pain at examination day and elevated pain scores.

CLINICAL RELEVANCE/APPLICATION

1. Biochemical lumbar disc alterations are associated with clinical symptoms like low back pain, radiculopathy, current pain or elevated pain scores. Additionally, participants with elevated BMI showed GAG loss of the lumbar IVDs. 2. Biochemical imaging with gagCEST may provide an early biomarker for IVD and spine degeneration. 3. GagCEST imaging may be helpful in monitoring therapy effects. 4. Molecular imaging with gagCEST is a non-ivasive tool that allows to dicriminate between healthy participants and patients with low back pain..

SSE18-02 Assessment of Imaging Appropriateness Based on the ACR Appropriateness Criteria in MRI Evaluation of Back Pain

Monday, Nov. 27 3:10PM - 3:20PM Room: N229

Participants
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PURPOSE

The purpose is to evaluate the appropriateness of MR imaging in the lumbar spine for back pain using ACR Appropriateness Criteria and to assess whether information provided by the requesting clinician at the time of order entry is adequate in allowing assessment of imaging appropriateness.

METHOD AND MATERIALS

This is a retrospective study of 111 outpatient MRI examinations of the lumbar spine performed for back pain. Cases were identified via an informatics query for MR exams associated with an ICD10 code of M54.5 (low back pain). Exclusion criteria included absence of a clinical note in the medical record. Using the history obtained, the study was placed into one of six Variants as outlined in the ACR Appropriateness Criteria document for Low Back Pain. Imaging appropriateness was assessed using only text provided by the clinician in the 'Reason for Exam' or 'Ordering Comments' fields, and appropriateness scores were assigned for the Variant that was deemed most likely based on the limited information provided. Following review of the medical record, each MRI exam was re-categorized into one of six Variants based on history components or potential 'red flags' as outlined in the ACR Appropriateness Criteria document. Based on the Variant assigned, the study was then given a rating of 1-9 based on the ACR Appropriateness Criteria, with 1-3 considered 'usually not appropriate' and 7-9 considered 'usually appropriate'.

RESULTS

Of the 111 MRI examinations reviewed, 15 were excluded due to aforementioned criteria. After review of the medical record for the included 96 studies, 77 (80%; 95% CI: 72-88%) ultimately received a rating of at least 7, the range considered 'usually appropriate'. Based solely on the clinician-provided 'Reason for Exam' or 'Ordering Comments' fields, 25 exams (26%; 95% CI: 17-35%) were considered 'usually appropriate'.

CONCLUSION

Most lumbar spine MRI examinations for low back pain are appropriate based on ACR Appropriateness Criteria, but a large portion of appropriate examinations could be falsely deemed inappropriate if only information provided by the clinician at order entry is evaluated.

CLINICAL RELEVANCE/APPLICATION

Communication of relevant clinical information from referring providers improves assessment of imaging appropriateness at the time of protocolling, performing, or interpreting a lumbar spine MRI study.

SSE18-03 Immunotherapy Associated Pseudoprogression of Spinal Leptomeningeal Disease

Monday, Nov. 27 3:20PM - 3:30PM Room: N229

Participants
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PURPOSE

Metastatic melanoma (MM) with leptomeningeal disease (LMD) has a poor prognosis. Immunotherapy has recently demonstrated improved outcomes, but very little is known about changes on imaging studies in the central nervous system during treatment. The purpose of this study was to characterize the imaging features of spinal leptomeningeal enhancement in metastatic melanoma patients during intrathecal (IT) interleukin-2 (IL-2) immunotherapy for LMD.

METHOD AND MATERIALS

The clinical and imaging data of 43 MM patients with LMD undergoing treatment with IT IL-2 were retrospectively reviewed. IL-2 was administered via an Omaya reservoir daily for 5 days during the 1st week, and 2-3 times per week for an additional 3 weeks, guided by patients' tolerance to treatment.

RESULTS

In 8 cases increased spinal leptomeningeal enhancement was identified after the initial IT administration of IL-2. The median time interval between administration of IL-2 and increase in the leptomeningeal enhancement in the first follow-up scan was 24 days. In all 8 cases there was a decrease in leptomeningeal enhancement on the subsequent scan acquired at a median of 38.5 days after the first follow-up MRI study.

CONCLUSION

Intrathecal IL-2 immunotherapy can result in a transient increase in spinal leptomeningeal enhancement. This is likely reflective of pseudoprogression secondary to IL-2 induced inflammatory reaction.

CLINICAL RELEVANCE/APPLICATION

Radiologists interpreting MRI spine studies in MM patients with LMD receiving intrathecal IL-2 should be cognizant of this transient increase in leptomeningeal enhancement so as to not mistake it for disease progression.

SSE18-04 High Field Magnetic Resonance Imaging of Microstructural Changes in Post-Mortem ALS Spinal Cord

Monday, Nov. 27 3:30PM - 3:40PM Room: N229

Participants
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PURPOSE

Amyotrophic lateral sclerosis (ALS) is characterized by progressive loss of upper (UMN) and lower motor neurons. UMN loss leads to degeneration of lateral and ventral corticospinal tracts (LCST and VCST). In this work we imaged post-mortem ALS spinal cord with diffusion tensor imaging (DTI) and echo-planar spectroscopic imaging (EPSI) and correlated results with histology. Both methods are sensitive to microstructural tissue changes and may serve as biomarkers of disease.

METHOD AND MATERIALS

Cord sections were imaged at 9.4T. DTI data were acquired using a Stejkal-Tanner sequence over 60 directions (b=3000s/mm^2, 0.1x0.1x0.4mm voxels) and radial diffusivity (rADC) was computed. EPSI data were acquired using a multi-gradient echo pulse sequence (128 echoes, 1.85ms echo spacing, 0.07mm^3 voxels) from which voxel-wise water proton spectra were produced. The asymmetry (ASYM) of each spectrum was computed as the integral of the spectral half below the peak subtracted from that above the peak (normalized by the total peak area). Regions of interest (ROIs) were defined in myelin stained (LFB) histology and registered with MRI data.

RESULTS

Increased rADC values in left and right LCSTs and VCSTs reflect ALS dependent neuronal loss compared with unaffected dorsal column (DC) white matter (2.07, 2.08, 2.1, 2.13, and 1.79 x10^-4 mm^2/s, respectively). ASYM values computed across the same ROIs also suggest sensitivity of the water spectrum shape to disease. The spectrum shape is sensitive to microstructural magnetic field perturbations, such as demyelination. ASYM values in CST ROIs are smaller than the more heavily myelinated DC and larger than the myelin free grey matter.

CONCLUSION

rADC and ASYM values are sensitive to ALS pathology in post-mortem spinal cord and could potentially serve as a biomarker to stratify UMN burden in ALS. Both rADC and ASYM results suggest sensitivity to underlying microstructural tissue changes. Of particular interest, similar myelin concentrations between VCSTs and LCSTs produce opposite changes in the water spectrum; positive asymmetry suggests increased spectral density at frequencies above the peak, while negative asymmetry suggests the same, but below it.

CLINICAL RELEVANCE/APPLICATION

These results obtained from post-mortem tissue suggest methods that could be used in vivo for non-invasive assessment of ALS as well as serve as an intermediary between histopathology and in vivo MRI.

SSE18-05 Comparative Analysis of Conventional T2 MRI versus Volumetric T2 MRI in the Evaluation of Spinal Vascular Malformations

Monday, Nov. 27 3:40PM - 3:50PM Room: N229

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Importance of volumetric T2 in spinal vascular malformations is less studied. Our objective was to determine the sensitivity and specificity of conventional T2 as well as volumetric T2 imaging findings in the detection of spinal vascular malformations.

METHOD AND MATERIALS

We conducted a retrospective case control study of subjects, who had spinal DSA for suspected vascular malformations, during a 11-year period from Jan 2006 to Dec 2016. Subjects with angiographically proven vascular malformations were taken as cases and remaining as controls. Anonymized images of conventional T2 and volumetric T2 MR sequences were analysed at an interval of 2 weeks. MRI was evaluated for the presence of flow voids, cord hyper-intensity, cord expansion, presence of nidus, based on which the spinal vascular malformations was identified. The sensitivity and specificity of these MRI observations in both conventional T2 and Volumetric T2 was analysed.

RESULTS

Totally 89 subjects were included in the final analysis. There were 70 angiographically proven vascular malformations {38 cases were spinal cord arterio-venous malformations (SCAVM) which includes spinal arteriovenous malformations and peri-medullary AV

fistulas, 32 cases were spinal dural AV fistulas(SDAVF)} and remaining 19 were normal. The sensitivity and specificity of flow voids in the identification of spinal vascular malformations were 98.1% and 90% for volumetric T2 sequences, compared to 83% and 89.4% of conventional MRI. For detecting flow voids in SDAVF, Volumetric T2 had 100% sensitivity while conventional T2 had only 71.8% sensitivity. For SCAVM sensitivity of volumetric T2 (96.4%) was slightly better compared to conventional T2 (92%). There was no significant difference in nidus detection rate between conventional (77%) and volumetric T2 (78.9%).

CONCLUSION

Volumetric imaging is superior to conventional T2 MR sequences in detecting vascular malformations, especially SDAVF. This sequence should be routinely included in the evaluation of suspected spinal vascular malformations.

CLINICAL RELEVANCE/APPLICATION

1. Spinal vascular malformations are a rare entity and failure to detect and treat early can lead to devastating complications. 2. Conventional T2 has significantly very low sensitivity compared to volumetric T2, in detecting spinal vascular malformations, especially for SDAVF. 3. Volumetric T2 MRI should routinely be done in all suspected spinal vascular malformations.

SSE18-06 MRI Features of Aquaporin-4 Immunoglobulin G Antibody Positive Longitudinally Extensive Transverse Myelitis (LETM) in Asians: Suggestive of Neuromyelitis Optica Spectrum Disorders

Monday, Nov. 27 3:50PM - 4:00PM Room: N229

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PURPOSE

To evaluate imaging features of spinal cord MRI for aquaporin-4 immunoglobulin G antibody (AQP4-IgG) positive longitudinally extensive transverse myelitis (LETM), which is highly associated with neuromyelitis optica spectrum disorders (NMOSD).

METHOD AND MATERIALS

This study was approved by the institutional review board. Forty-one patients with LETM from 2004 to 2014 who underwent aquaporin-4 antibody test were included in our study. Cervicomedullary junction extension, cord expansion ratio, bright spotty lesion, number of involved segments, presence of skipped lesion, enhancement pattern, axial distribution pattern was evaluated in spine MRI. Univariate logistic regression analysis was performed to identify factors associated with the presence of AQP4-IgG positive results. Statistically significant factors which was associated with AQP4-IgG positive results were used to build a scoring system. Interrater reliability for the measurement of cord expansion was evaluated using the intraclass correlation coefficient derived from a 2-way mixed effects model. Interrater agreement for the judging the presence of bright spotty lesion was evaluated with kappa values.

RESULTS

Fifteen patients (15/41, 38.9%) were aquaporin-4 antibody positive LETM. The regression analysis showed that gender, cervicomedullary junction extension, cord expansion ratio > 1.4, and bright spotty lesion was significantly associated with positive AQP4-IgG result.The sensitivity of the scoring system was 73.3% and specificity was 96.2%. Interclass correlation value of the cord expansion ratio was 0.78 and Kappa value of bright spotty lesion was 0.61.

CONCLUSION

Cervicomedullary junction extension, higher cord expansion ratio, bright spotty lesion, and female highly suggests AQP4-IgG positive in LETM, which is highly suggestive of NMOSD.

CLINICAL RELEVANCE/APPLICATION

The result of AQP4-IgG which orientates the treatment in LETM, could be predicted with specific spinal MRI findings(cervicomedullary junction extension, higher cord expansion ratio, bright spotty lesion) and gender.

SSE19

Neuroradiology (CNS Trauma: What is Broken?)

Monday, Nov. 27 3:00PM - 4:00PM Room: N230B

ER NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Asim Z. Mian, MD, Boston, MA (*Moderator*) Stockholder, Boston Imaging Core Lab, LLC
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Sub-Events

SSE19-01 Reproducibility of Advanced Neuroimaging Metrics across Sessions, Sites, and Subjects

Monday, Nov. 27 3:00PM - 3:10PM Room: N230B

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PURPOSE

This work reports a portion of a large study of sports related concussion (SRC) and head impact exposure in collegiate athletes and service academy cadets. A subset of subjects have been enrolled in an enhanced protocol, which includes head impact measurement, blood biomarker assessment, and magnetic resonance imaging (MRI). Here we assess the stability of metrics derived from the MRI examination in subjects in non-contact sports. This is foundational to the larger study, establishing a baseline of noise across MRI measurements above which effects must rise to be observed.

METHOD AND MATERIALS

Imaging was performed on the GE Healthcare (one site), and Siemens (three sites). Imaging parameters of normalized T1 weighted, normalized T2 FLAIR weighted, normalized T2* weighted, quantified T2*, mean diffusivity, fractional anisotropy, relative cerebral blood flow, fractional amplitude of low frequency BOLD fluctuations, and regional homogeneity of low frequency BOLD fluctuations. Coefficients of variation for each metric were computed across: repeated sessions for each subject (n=30), traveling human phantoms imaged at each site (n=2), and subjects at each site (n=35).

RESULTS

Coefficients of variation were found to be lowest within subjects over scanning sessions in all contrasts. In all regions of interest, except deep brain gray matter regions of interest in T2* weighted images and cerebrospinal fluid regions of interest in T2 FLAIR and mean diffusivity contrasts, the between-subject coefficient of variation was greater the between-site coefficient of variation. In these regions of interest and contrast combinations, however, the considered signal is expected to be poor.

CONCLUSION

Results of this study illustrate the stability of the larger-scale SRC study. Within-subject repeatability is very good, even over the span of 60 days, which will allow detailed consideration of the time course of SRC (or exposure) and recovery. Between-site stability was greater than subject-to-subject stability. Thus, the inter-site and inter-vendor study design, which enables large-scale recruitment of injured athletes, does not negatively impact the pooling of data across the sites.

CLINICAL RELEVANCE/APPLICATION

This establishes stability expected in multi-center neuroimaging studies with advanced imaging technology. Cross-site variability was less than cross-subject, and intra-subject repeatability was best.

SSE19-02 Computed Tomography (CT) Overuse for Minor Head Injury (MHI) in Young Patients: Analysis of Contributing Factors

Monday, Nov. 27 3:10PM - 3:20PM Room: N230B

Participants
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PURPOSE

To assess the amount of CT scan for MHI performed in young patients in our Emergency Department (ED), that are not indicated by National Institute for Health and Care Excellence (NICE) and Canadian CT Head Rule (CCHR) guidelines and to analyze factors that contribute to unnecessary examinations.

METHOD AND MATERIALS

We retrospectively evaluated head CT examinations performed for MHI in patients aged 18-45 years who presented to our ED from January 1 to June 30 2016. Medical records were assessed for the following parameters: demographics, cause of head trauma, referring physician's seniority and specialty. For each CT scan, it was determined whether the CT referral met the NICE and CCHR criteria and was calculated the effective dose (ED) from the dose-length product.

RESULTS

A total of 492 CT examinations were collected; 260 (52.8%) and 376 (76.4%) examinations were not indicated according to the CCHR and NICE, respectively. There was no statistically significant difference between the specialty and seniority of the referring physician and over-referral (p=.29, p=.87, respectively, for CCHR; p=.24, p=.95, respectively, for NICE) and between patient's age and unwarranted CT studies (p=.81 for CCHR and p=.79 for NICE). Motor vehicle accidents (as a passenger or driver) were associated with a higher rate of non-indicated CT examinations for both CCHR (p=.018) and NICE (p=.02), 2-wheel vehicle driver accidents were associated with a higher rate of appropriate CT exams for both CCHR and NICE (p<.01). Only 15 CT scans were positive (brain hemorrhages, subarachnoid hemorrhage, skull fracture). In our study, CCHR and NICE had sensitivity and NPV of 100% for brain injury. Mean ED for head CT scan was 2.6+/-0.3 mSv. Analyzing our series of patients, we found a correlation between young age of patients (<25 years) and sports injuries (p=.02) and between seizures and CT positive for brain injury (p=0.012).

CONCLUSION

We demonstrate an important overuse of CT examinations for MHI in young patients in our ED, with an excess of 52.2 and 76.4% according to the CCHR and NICE, respectively. The main contributing factor for over referral was injury mechanism.

CLINICAL RELEVANCE/APPLICATION

CT overuse cases unnecessary radiation exposure and health care burden. An analysis of the causes for overuse should be carried out in every ED to target specific intervention, as education of staff members and revision of the management protocols.

SSE19-03 Increased Cerebral Venous Oxygen Saturation in Mild Traumatic Brain Injury Patients Using Quantitative Susceptibility Mapping

Monday, Nov. 27 3:20PM - 3:30PM Room: N230B

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PURPOSE

To explore the relative changes of regional cerebral venous oxygen saturation (SvO2) using quantitative susceptibility mapping (QSM) in mild traumatic brain injury (mTBI) patients and correlation with elapsed time post trauma (ETPT) and post-concussion symptoms.

METHOD AND MATERIALS

32 mTBI patients and 32 age-and gender-matched healthy controls (HCs) were enrolled in this prospective study. The diagnosis of mTBI was made based on the definition of mTBI by the American Congress of Rehabilitation Medicine. No abnormal findings were found in the CT and MRI examination of mTBI patients. QSM reconstructed from original phase data of 3.0T susceptibility weighted imaging was used to measure the susceptibility of major cerebral veins and calculate the relative changes of cerebral SvO2. Spearman's correlation analysis was performed to explore the correlation between ETPT, post-concussion symptoms and the susceptibility of major cerebral veins. The receiver operating characteristic curve (ROC) was performed for the diagnostic efficiency of susceptibility to discriminate mTBI patients from HCs.

RESULTS

The susceptibility of straight sinus in mTBI patients was 255.51±35.25 ppb, which was significantly lower than HCs (310.63±43.05

ppb, P=0.000). The cerebral SvO2 of straight sinus in mTBI patients was increased 5.32%. The susceptibility of straight sinus in mTBI patients correlated with ETPT (r=0.573, P=0.003). The best cut-off susceptibility for the discrimination between mTBI patients and HCs was 272.52 ppb with a sensitivity of 75.00% (95%CI:57-89), specificity 84.37% (95%CI:67-95), and AUC value 0.86 (95%CI:0.75-0.93). The susceptibility of straight sinus did not correlate with the Rivermead post-concussion symptoms questionnaire scores (P>0.05).

CONCLUSION

The decreased susceptibility of straight sinus in mTBI patients indicated the increased cerebral SvO2, which returned back to normal level with ETPT. The susceptibility of straight sinus can be used to discriminate the mTBI patients from HCs.

CLINICAL RELEVANCE/APPLICATION

The susceptibility of straight sinus can be used to discriminate the mTBI patients from healthy controls. The susceptibility can be used to evaluate the condition of mTBI patients relative to ETPT.

SSE19-04 Intra-Default Mode Network Connectivity Changes from a Single Season of Youth Football Distinguish Levels of Head Impact Exposure

Monday, Nov. 27 3:30PM - 3:40PM Room: N230B

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PURPOSE

This purpose of this study is to determine whether intra-default mode network (DMN) connectivity changes occur from youth (ages 9-13) contact sports using a machine learning-based approach.

METHOD AND MATERIALS

In this IRB-approved study of youth football athletes, each player was instrumented with the HIT system to record head impact acceleration. The seasonal risk of concussion was calculated by converting each impact into a risk of concussion and summing to a value, the player's risk of concussion-weighted cumulative exposure (RWE). Players were dichotomized into highest and lowest 10% exposure groups (13/group). Players experiencing a concussion or with a history of concussion were excluded. 13 non-contact sport controls were used as a third group. A pre and post-season 6 minute rs-fMRI was performed in all players and controls at 3-month scan interval. The fMRI data was preprocessed for motion correction, spatial smoothing and normalization. Resting-state network (RSN) sub-components, including DMN sub-components, were extracted using a higher order (60 component) group independent-components analysis (ICA). 8 DMN sub-components were identified and back-reconstructed to form individual subject's DMN sub-components pre- and post-season. Connectivity was computed using Pearson's correlation between sub-component mean time courses. The post minus pre-season connectivity changes formed our features. Five machine learning classification algorithms were evaluated to predict whether a player was a non-contact, low, or high impact exposure player.

RESULTS

Ten-fold cross validation results demonstrated for a Linear SVM classifier accuracy (82%) discriminating high impact and control groups, moderate accuracy (70%) between control and low exposure players, and roughly chance classification accuracy (60%) between high and low impact. The results suggest an increasing functional change with increasing head impact exposure.

CONCLUSION

Our work suggests that RSN sub-components of can be extracted from rs-fMRI using ICA, analyzed with deep learning, and that the connectivities of the DMN sub-components are altered by repeated sub-concussive head impact exposure.

CLINICAL RELEVANCE/APPLICATION

This work demonstrates that playing a season of contact sports at the youth level, when brains are undergoing maturation, can produce neuroimaging brain changes, particularly for the DMN.

SSE19-05 MEG Measured Default Mode Network is Altered by History of Concussion in High School Football

Monday, Nov. 27 3:40PM - 3:50PM Room: N230B

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PURPOSE

The purpose of this study is to determine if history of previous concussion modulates connectivity changes in the magnetoencephalography (MEG) measured default mode network (DMN).

METHOD AND MATERIALS

Twenty players from a high school football team (mean age=16.9; right handed) were included in this study. Eight minutes of eyes-open, resting-state MEG data were acquired for each subject using a 275 channel CTF whole-head system, pre- and post-season. Structural anatomic MRI was acquired for co-registration with MEG. Using Brainstorm, MEG data were pre-processed and filtered to 1-100Hz. Eye blinks, and muscle artifacts were removed using independent component analysis. MEG data were projected into standard source space using the whitened and depth-weighted linear L2-minimum norm estimates algorithm (wMNE). A mean time series was extracted from eight regions of interest (ROIs) representing the DMN: inferior parietal L&R, medial orbitofrontal L&R, posterior cingulate L&R, superior frontal L&R. The correlation between all ROIs was computed. Each correlation was converted to z-scores, the average DMN correlation was computed, and the difference between pre- and post-season correlation was computed. The subjects were divided into two groups: those with a history of concussion (N=5) and those without a history of concussion (N=15). A two sample t-test was performed to estimate the difference in mean DMN correlation between the two groups.

RESULTS

Subjects with a history of concussion had significantly lower DMN correlations from pre-season to post-season ($p = 0.001$). The subjects with previous concussions had a negative change in correlation whereas subjects without a history of concussion had, on average, a positive change. No significant differences were found in age, BMI, or head impact exposure between the two groups. One data point was excluded based on outlier analysis.

CONCLUSION

Changes in the MEG measured DMN, over a season of football, may be dependent on the subject's history of concussion. fMRI literature has also demonstrated changes in the DMN are dependent on the history of concussion. Our previous work has shown that concussion history can modulate DMN connectivity changes associated with head impact exposure.

CLINICAL RELEVANCE/APPLICATION

MEG has shown promise as a sensitive modality for concussion diagnosis. Prior concussion history should be considered when performing analyses of MEG data involving repeated head impacts.

SSE19-06 Alteration of Brain Structure and Neural Function after Cervical Spinal Cord Injury

Monday, Nov. 27 3:50PM - 4:00PM Room: N230B

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PURPOSE

To explore the alterations of brain structural and functional after cervical spinal cord injury (CSCI) combined with voxel-based morphometry (VBM) and resting-state functional magnetic resonance imaging (fMRI), and to further study their associations with clinical variables.

METHOD AND MATERIALS

22 patients with traumatic CSCI and 22 age- and sex-matched healthy controls (HCs) were recruited. The CSCI was divided into acute (duration<1month;12 cases) and subacute-chronic (duration >1months;10 cases) group based on the injury duration. The 3D-T1WI and resting-state fMRI of all subjects were obtained using a 3.0 Tesla MRI system. VBM analysis was carried out to investigate the differences in GMV between patients with CSCI and HCs. Region of interest (ROI) based functional connectivity (FC) analysis was performed to study changes in the whole brain using the results of VBM as seed regions. Disease duration and American Spinal Injury Association (ASIA) Scale scores were also obtained from each patient. Associations between structural and functional changes and clinical variables were also analyzed. Using the general linear model in SPM, a voxel-wise two-sample t-test was used to compare the GMV differences between the CSCI group and the HC group, and between subgroups. Partial correlation analysis was performed to explore any potential association between structural and functional changes and clinical variables in patients with CSCI.

RESULTS

Compared with HCs, patients with CSCI showed significant gray matter volume (GMV) decrease in the right anterior insular cortex, right dorsal anterior cingulate cortex (dACC), bilateral orbital frontal cortex (OFC), and left Lingual gyrus(Fig.A). No significant difference in GMV in these areas was found between the acute and subacute-chronic sub-group. Furthermore, SCI patients showed decreased FC in left primary sensorimotor cortex (Fig.B) and this decreased FC negatively correlated with the VAS score (Fig.C).

CONCLUSION

Our study indicate that CSCI can cause dramatically atrophy of GMV in the core hubs of Salience Network and network-level functional alterations in the sensorimotor cortical regions, and the decreased FC within the left primary sensorimotor cortex negatively related to VAS score.

CLINICAL RELEVANCE/APPLICATION

These findings may provide new insights into the structural and functional plasticity of brain after CSCI.

SSE20

Pediatrics (Pediatric Oncology and Nuclear Medicine)

Monday, Nov. 27 3:00PM - 4:00PM Room: S102CD

NM PD

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSE20-01 Ferumoxytol-enhanced MR Imaging of Tumor Associated Macrophages: Clinical Translation

Monday, Nov. 27 3:00PM - 3:10PM Room: S102CD

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PURPOSE

Tumor associated macrophages (TAM) are key components of the tumor microenvironment and play a role in the pathogenesis and progression of many tumors. As new TAM-targeted immunotherapies are entering clinical trials, it becomes important to detect and quantify TAM with non-invasive imaging techniques. The purpose of this study was to determine if ferumoxytol-enhanced MRI can detect TAM in lymphomas and sarcomas of pediatric patients and young adults.

METHOD AND MATERIALS

In a single center, IRB-approved prospective clinical trial, 28 pediatric patients and young adults with lymphoma (n=15) or sarcoma (n=13) underwent MR imaging before, at 1-4 hours and at 20-24 hours after intravenous injection of ferumoxytol. MR sequences included STIR, T1-weighted SPGR, multi-echo T2* FSPGR and R2* IDEAL IQ sequences. Histopathology evaluation was performed by 2 pathologists with prussian blue and immunohistochemistry stains for macrophage markers CD-68 and CD-163. A threefold approach was taken to evaluate the ability of MRI to image TAMs: (1) In a pilot study of 3 patients who underwent pre and post contrast imaging, we confirmed tumor ferumoxytol enhancement. (2) To determine if ferumoxytol-MRI can differentiate tumors with different TAM content, we compared T2* enhancement data of lymphomas and sarcomas. (3) In all patients, we correlated tumor T2* values on post-contrast scans with TAM quantity on histopathology.

RESULTS

Tumor areas that showed hypointense enhancement on both T1- and T2-(or T2*)-weighted sequences were considered positive for TAM on MRI. (1) Significant iron oxide tumor enhancement was noted on post-contrast scans compared to pre-contrast scans ($p = 0.013$). (2) A significant difference in post-contrast T2* relaxation times was noted between lymphomas and sarcomas at 20 hr p.i. ($p=0.0005$) (3) All tumors demonstrated TAM on immunohistochemistry, with a positive correlation between T2* and TAM quantity (Pearson $r = 0.45$, $p < 0.0001$).

CONCLUSION

TAM can be detected in lymphomas and sarcomas of pediatric patients and young adults with ferumoxytol-enhanced MR Imaging.

CLINICAL RELEVANCE/APPLICATION

This non-invasive imaging test may help to study the effect of immune responses on tumor progression and outcomes in pediatric patients and serve as a new biomarker monitoring of new immune-targeted therapies.

SSE20-02 Spectral Ultrasound Parameters Could Predict Development of Sinusoidal Obstructive Syndrome in Pediatric Bone Marrow Transplant Patients

Monday, Nov. 27 3:10PM - 3:20PM Room: S102CD

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PURPOSE

Hepatic sinusoidal obstruction syndrome (SOS) is a potentially fatal complication following bone marrow transplantation (BMT). Imaging diagnosis of SOS is difficult because the only reported reliable indicator occurs very late in the clinical disease (reversal of portal venous flow). Our study objective was to identify other differences in spectral Doppler ultrasound parameters between BMT patients who developed SOS and those who did not.

METHOD AND MATERIALS

A single center cohort retrospective study was conducted on patients ages 0-21 years who underwent a BMT between September 2001 and May 2016. Patients were excluded if they did not have abdominal ultrasounds following BMT. Clinical information about the conditioning regimen and reasons for transplant, as well as spectral Doppler liver ultrasound findings were evaluated. The independent associations of Doppler ultrasound variables were assessed using hierarchical multivariable linear regression models which accounted for repeated measures and adjusted for number of relapses, regimen and disease type. ROC analysis was performed for main portal vein (MPV) peak velocity.

RESULTS

A total of 280 patients received a BMT and 161 were excluded due to lack of ultrasounds yielding 119 total subjects included in our cohort. 22 (18%) of the patients developed SOS. Several spectral Doppler ultrasound variables were statistically different between patients with SOS and those without. These variables included: end-diastolic and peak-systolic velocities of the main hepatic artery and the MPV peak velocity. Peak MPV velocity of 12.6 cm/s has 51% sensitivity and 88% specificity for SOS. Area under the ROC curve was 0.75. Branch hepatic artery velocities were also statistically different.

CONCLUSION

Spectral Doppler ultrasound variables such as MPV velocity are statistically different between SOS and non-SOS cohorts even after adjusting for clinical confounders.

CLINICAL RELEVANCE/APPLICATION

Spectral Doppler could be useful in risk stratifying pediatric BMT patients for development of SOS. MPV velocity could potentially identify these patients earlier than our current imaging parameters.

SSE20-03 Effect of Image-Defined Risk Factors for Surgical Treatment of Localized Neuroblastoma in Children: A Single Center Retrospective Study

Monday, Nov. 27 3:20PM - 3:30PM Room: S102CD

Participants
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PURPOSE

The purpose of this study was to present the effect of image-defined risk factors (IDRF) according to the INRG (International Neuroblastoma Risk Group) Staging System for surgical resectability and complication in localized neuroblastoma.

METHOD AND MATERIALS

Forty-two patients (20 males and 22 females, median age, 44.5 months) were retrospectively reviewed, who were diagnosed localized neuroblastoma between January, 2007 and December, 2010. These 42 patients underwent CT and/or MRI before surgical intervention or any other treatment. MSCT was performed on a 16-row CT scanner (Lightspeed 16, General Electric Medical Systems) and MRI on a 1.5 Tesla scanner (Signa; General Electric Medical Systems, Seattle, Wash.). We evaluated all 42 patients' initial imaging to identify IDRFs according to the INRG Staging System, and collected data including primary tumor site, INSS (International Neuroblastoma Staging System), initial surgical intervention, surgical complications and outcomes.

RESULTS

Forty-two neuroblastomas (abdomen 22, pelvis 3, mediastinum 10, neck 7) were evaluated. Total resection was underwent in 10 cases (24%), partial or subtotal resection in 7 cases (17%), and biopsy in 25 cases (59%). Fourteen percent (6/42) of the patients were presented no IDRFs (Stage L1). Total resection was performed in all six cases (Stage L1). Eighty-six percent (36/42) of the patients were presented one or more IDRF (Stage L2). A total of 104 IDRFs in 36 cases were demonstrated in the CT or MRI. In these 36 cases (Stage L2), only 11% (4/36) of cases had total resection. There was a significant, negative correlation between the number of IDRFs and the possibility of total resection of neuroblastoma ($p < 0.05$). Three surgical renal complications (renal atrophy, renal artery injury and nephrectomy respectively) were detected in three patients, all of whom demonstrated encasement

of the renal artery or infiltration of kidney.

CONCLUSION

In localized neuroblastoma, IDRFs are useful for determining the potential surgical risks and surgical outcome, and the assessment of IDRFs should become an integral part of therapy planning.

CLINICAL RELEVANCE/APPLICATION

Image-defined risk factors (IDRFs) according to the INRG Staging System are useful for surgical treatment of localized neuroblastoma in children.

SSE20-04 Radioactive Iodine Uptake in the Breast Tissue Nulliparous Young Women

Monday, Nov. 27 3:30PM - 3:40PM Room: S102CD

Participants
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PURPOSE

Radioactive iodine uptake in the breast tissue of lactating women is well described and may lead to the false positive diagnosis of lung metastasis. In contrast, the frequency of breast uptake among nulliparous women has not been described. We performed this study to test the hypothesis that breast activity is present in the majority of young, nulliparous female patients undergoing whole body scintigraphy with radioactive iodine.

METHOD AND MATERIALS

All female patients with known primary thyroid cancer who underwent whole-body I-123 scintigraphy from 9/25/2014 through 3/22/2017 were eligible for inclusion. Parous patients and patients whose exams did not include lateral planar images were excluded. Four pediatric radiologists (10, 8, 7, and 5 years post-fellowship experience) with additional subspecialty training in nuclear radiology evaluated I-123 whole body scintigraphy exams for the presence of breast activity on a 5-point Likert scale (1=highly unlikely; 5=highly likely). Four findings on planar images were evaluated independently by each of the readers: activity 1) present on the frontal images, 2) limited to the lower thorax on frontal images, 3) present on lateral images, and 4) present given all projections. Mean Likert values were calculated for each finding. Reader agreement on the Likert scale was measured by modified Fleiss's Kappa with weight and 95% CIs were calculated by Monte Carlo simulation.

RESULTS

During the study period 27 patients met inclusion criteria (mean age=15.9+/-2.3 years), - no patients were excluded. Mean Likert scores and agreement were: present on frontal images= 3.9 +/- 1.2, κ=0.74 (0.61-0.83); limited to the lower thorax on frontal images= 4.0 +/- 1.2, κ=0.77 (0.63 - 0.88); present on lateral images= 4.2 +/- 1.2, κ=0.85 (0.71 - 0.93); and present given all projections= 4.2 +/- 1.3, κ=0.85 (0.71 - 0.94).

CONCLUSION

Breast activity is present in the majority of nulliparous young women. Knowledge of this high frequency should minimize interpretations false positive for lung metastasis. We recommend routine lateral images of patients undergoing radioactive iodine scintigraphy for evaluation of thyroid cancer to confirm activity is located to the breast and not intrathoracic.

CLINICAL RELEVANCE/APPLICATION

Knowledge of the high frequency of normal breast activity among young women undergoing I-123 scintigraphy should minimize interpretations false positive for lung metastasis.

SSE20-05 Differentiating High Uptake Normal Tissues From Tumor Using Pet Derived Radiomics Features

Monday, Nov. 27 3:40PM - 3:50PM Room: S102CD

Participants
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PURPOSE

Identification of FDG avid cancerous lesions can be obscured by high uptake normal tissues. In this study, we introduce a PET radiomics based tissue classifier for differentiating FDG avid normal tissues from tumor.

METHOD AND MATERIALS

Attenuation corrected PET intensities were converted to SUV for thresholding and segmented using a watershed algorithm. Gaussian filtering was used to suppress over segmentation of normal structures. Neighboring segments were combined using distance and SUV based criteria. A training set including 33 PET scans from 15 patients were used to segment 148 FDG avid regions. Ground truth classification was assigned to each volume as one of four classes, brain, bladder, heart, or others. Image and

shape based features were extracted from the training set to construct a support vector machine (SVM) prediction model. Classification performance was evaluated with additional 58 PET scans from 21 patients using the same image processing and feature analysis scheme. 215 FDG avid regions were labeled using the classifier.

RESULTS

The classifier correctly differentiated normal tissue from disease in 199 automatically segmented FDG-avid regions with 92% accuracy. The brain, heart and bladder were misclassified in 9, 4, and 3 cases, respectively. Heart misclassification was due to inconsistent uptake in the training set as 17 and 8 scans had absent or partial heart uptake. Brain misclassification was due to variation in volume given the difference in age range in the training and validation dataset (mean 5 vs. 13 years, p <= 0.001). Misclassified brain volumes were 694, 1036, 882, 992 mL (mean 1556, Z score 2.1, 1.3, 1.7, 1.6). Bladder misclassification was due to differences in intensity characteristics and bladder volume. One with large volume of 657 mL (mean 251.4, Z score 2.1), one with small surface area of 5.7 cm2 (mean 21, Z score 1.3), and one with a skewness of 5.3 (mean 2.3, Z score 1.7).

CONCLUSION

In this study, we demonstrated accurate automatic classification of high uptake normal tissues from PET studies using radiomics based SVM. Future improvements combining CT and PET radiomics features may improve segmentation and classification of FDG-avid regions and the assessment of disease burden and therapeutic response.

CLINICAL RELEVANCE/APPLICATION

Successful automatic classification facilitates radiomics analysis of FDG avid tissues potentially aids the assessment of total disease burden and response.

SSE20-06 Prognostic Value of FDG PET Metabolic Tumor Burden Parameters in High-Risk Pediatric Hodgkin Lymphoma (COG Trial AHOD0831)

Monday, Nov. 27 3:50PM - 4:00PM Room: S102CD

Participants
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PURPOSE

Bulk disease at staging is a known unfavorable risk factor in Hodgkin's lymphoma (HL). We compared the prognostic value of current anatomic mediastinal tumor bulk measurements with mediastinal and total metabolic tumor burden obtained from FDG PET/CT in high risk pediatric HL.

METHOD AND MATERIALS

Data were acquired from the COG AHOD0831 high-risk pediatric HL phase III trial in 94 of 164 patients with good-quality CXR, CT and FDG PET/CT obtained prior to therapy. Mediastinal bulk was defined as: mediastinal mass ratio (MMR) >0.33 on CXR, mediastinal mass diameters (MMD) >=10cm on CT, and mediastinal mass volume (MMV) >=200 ml on CT measured using the three largest perpendicular diameters. PET based parameters included SUVmax, SUVpeak, metabolic tumor volume (MTV), and total lesion glycolysis incorporating both MTV and FDG uptake (TLG). MTV and TLG were derived using absolute SUV 2.5 (SUV2.5) and 40% maximum tumor SUV (SUVmax40%) thresholds from mediastinal mass (mMTV and mTLG) and all FDG avid lymphadenopathy (tMTV and tTLG). An optimized cutoff value for PET parameters used a Youden index on receiver-operating characteristic (ROC) curve to determine high and low-risk groups. Kaplan-Meier survival analysis for event-free survival (EFS) was performed.

RESULTS

Standard anatomic mediastinal bulk disease defined as MMR and MMV was associated with lower EFS (p=0.034 for MMR and p=0.015 for MMV) with no difference with MMD. Mediastinal tumor PET parameters were not predictive of EFS. However, increased total metabolic tumor burden using TLG was associated with lower EFS (p=0.034 for tTLG2.5 and p=0.044 for tTLG40%, (Figure 1)) but other parameters were not predictive of survival. Increased total metabolic tumor burden was significantly associated with interim PET positivity (p=0.010 for tMTV2.5, p=0.0005 for tMTV40% and p=0.003 for tTLG40%).

CONCLUSION

In high-risk pediatric HL patients, baseline PET-based total metabolic tumor burden parameter, tTLG, was found to be predictive of survival. Both total metabolic tumor volume and level of glycolytic tumor activity may be needed to predict treatment outcome, which requires further validation in a larger cohort of patients.

CLINICAL RELEVANCE/APPLICATION

None.

SSE21

Physics (CT: Cone Beam)

Monday, Nov. 27 3:00PM - 4:00PM Room: S403A

CT PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSE21-01 Three-dimensional Digital Subtraction Angiography (3D-DSA) from a Single C-arm Acquisition Using a Convolutional Neural Networks-Based Deep-Learning Method

Monday, Nov. 27 3:00PM - 3:10PM Room: S403A

Participants
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PURPOSE

The purpose of this work was to develop a deep-learning method, based on convolutional neural networks (CNN), to generate 3D-DSA angiograms from a single contrast-enhanced exam without mask acquisition.

METHOD AND MATERIALS

Clinical image volumes of 30 patients scanned with a C-arm cone-bean CT system (Axiom Artis zee; Siemens Medical Solutions) using a standard 3D-DSA imaging protocol for the assessment of cerebrovascular abnormalities were retrospectively collected. Images from 22 subjects were used to extract labeled image patches that were used as training data set. A 30-layer CNN was trained to classify three tissue types (vasculature, bone and soft tissue). The trained CNN deep-learning model was then applied for the task of tissue classification in a test cohort consisting of the remaining image volumes from 8 subjects. The final vasculature tissue class was used to generate the 3D-DSA images. To quantify the generalization error of the trained model, tissue classification accuracy was measured in 8 million image patches from clinically relevant anatomy in the test data set. Finally, the generated 3D-DSA images were subject to a quantitative assessments of contrast enhancement in the internal carotid artery (ICA), middle cerebral artery (MCA), anterior cerebral artery (ACA) and the distal branches of the MCA and ACA. A qualitative assessment for the presence of inter-sweep motion artifacts was also performed.

RESULTS

Tissue classification accuracy in the testing dataset was 98.7% and 98.1% on a per-voxel and per-patient basis respectively. The average relative increase in vessel contrast enhancement compared to the vendor's DSA was 18.7%, 21.7%, 20.5% for the ICA, MCA, ACA respectively. Nearly a 2-fold increase in vessel opacification was observed for the distal branches of the MCA and ACA. No residual signal from osseous structures was observed for all cases generated using the proposed method.

CONCLUSION

A deep learning based method was developed to generate 3D-DSA images without mask data acquisition. The proposed method successfully eliminates mis-registration artifacts induced by inter-sweep patient motion, improves image quality and potentially reduces radiation dose in clinical 3D-DSA imaging.

CLINICAL RELEVANCE/APPLICATION

Mask-free 3D-DSA imaging using a deep-learning based method may allow radiation dose reduction by omitting a mask scan and eliminate mis-registration artifacts induced by inter-sweep patient motion.

SSE21-02 Time-Resolved CBCT Angiography (TR-CBCTA) Imaging from a Single-Sweep C-Arm CBCT Acquisition

Monday, Nov. 27 3:10PM - 3:20PM Room: S403A

Participants
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PURPOSE

Generating time-resolved cone-beam CT (CBCT) angiography (TR-CBCTA) images from multi-sweep CBCT acquisition has previously been demonstrated. To reduce dose, motion artifacts, and data acquisition time, in this work, a new technique was developed to generate high-quality TR-CBCTA images from a single-sweep CBCT data acquisition.

METHOD AND MATERIALS

A newly developed image reconstruction technique, Synchronized Multi-Artifact Reduction with Tomographic Reconstruction (SMART-RECON), enables several sub-image frames to be generated from a single 200-degree contrast enhanced scan. Each sub-image frame corresponds to a short segment of the projection data, but using SMART-RECON is reconstructed without limited-view artifacts. The first virtual non-contrast enhanced sub-image frame is subtracted from other sub-image frames, generating the desired TR-CBCTA images without requiring a separate mask scan. The proposed method was applied retrospectively to intra-arterial (IA-DSA) datasets of 15 human subjects with various neurovascular pathologies such as aneurysms, large vessel occlusion, or arteriovenous malformation.

RESULTS

Single-sweep TR-CBCTA images of the 15 human subjects were successfully generated. These images demonstrated time- resolved information of the cerebrovascular contrast dynamics. In addition, they demonstrated potentially improved image quality compared with the clinical standard multi-sweep images, as they were less prone to artifacts arising from inter-sweep involuntary patient motions and misregistration. The noise standard deviations measured in the SMART-RECON enabled TR-CBCTA images are 11±2 HU, compared with 31±5 HU of clinical 3D-DSA images. The CNR values of SMART-RECON enabled TR-CBCTA images, and clinical 3D-DSA images are 18±10 and 8±3, respectively. The subjective conspicuity of neurovascular abnormalities such as aneurysms and stenoses was improved in the SMART-RECON enabled TR-CBCTA images.

CONCLUSION

High-quality TR-CBCTA imaging can be achieved using a single C-arm CBCT data acquisition to reduce overall image acquisition time, reduce artifacts associated with inadvertent patient motion, and reduce radiation dose.

CLINICAL RELEVANCE/APPLICATION

TR-CBCTA from a single CBCT scan enables clinicians to extract precious time-resolved information of vasculature from a single CBCT acquisition to reduce dose and reduce motion artifacts.

SSE21-03 Importance of Prior Information for Accurate Scatter Correction of Truncated Cone-Beam CT (CBCT) Data

Monday, Nov. 27 3:20PM - 3:30PM Room: S403A

Participants
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PURPOSE

To compare different methods of detruncation with respect to scatter correction and to provide a quantitative scatter correction approach for truncated CBCT data.

METHOD AND MATERIALS

In CBCT scatter correction is of high importance to obtain artifact-free and quantitative CT images. While scatter correction itself is difficult it becomes even more challenging when the data are longitudinally and laterally truncated due to limited detector sizes, as it is often the case in C-arm CT or in dental CT, for example. Several scatter correction methods and several detruncation methods are known and need to be combined. It is unclear to what accuracy the extrapolation needs to be done in order to get accurate CT images. We therefore combined our Monte Carlo-based scatter correction with several detruncation approaches: no (N), constant (C), cosine roll-off (R), adaptive (A) [EurRadiol 15:1008-1014, 2005], and prior-based (P) detruncation [MedPhys 41(2):021906, 2014]. The latter uses anatomical data of a different patient for data-completion. To validate our approach we corrected measured dental CBCT data of a head phantom and patients (truncated to 11 cm diameter due to small detector size), CBCT patient data of a pelvis scan (manually truncated) and C-arm CT phantom measurement of the QRM liver phantom (truncated to 24 cm diameter).

RESULTS

Images corrected by the simple detruncation algorithms suffer from an overestimated scatter, the reason being the overestimation of the detected intensities, making a patient specific empirical correction factor necessary. For the dental CBCT patient case the CT-values for soft tissue/dentin were corrected from -140/1094 HU (FDK reconstruction) to -30/1879 HU (N), -30/1905 HU (C), -10/1976 HU (R), -23/1975 HU (A) and 69/2375 HU (P). In all cases (P) leads to the most accurate CT-values while not requiring the empirical factor.

CONCLUSION

Prior-based detruncation leads to a proper and robust scatter estimation which is mainly important for scatter correction.

CLINICAL RELEVANCE/APPLICATION

Quantitative CT images from truncated CBCT scans are possible. However, scatter correction must be combined with strong prior information incorporating anatomical data from a similar patient.

SSE21-04 Compensating for Irregular Respiratory Motion in Cone-Beam CT (CBCT): Motion Vector Field Resampling

Monday, Nov. 27 3:30PM - 3:40PM Room: S403A

Participants
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PURPOSE

To minimize motion blurring in 4D respiratory motion-compensated CBCT in case of irregular breathing patterns.

METHOD AND MATERIALS

CBCT images often suffer from respiratory motion. Gated reconstruction minimizes the motion artifacts but introduces significant sparse view artifacts. Motion-compensated (MoCo) image reconstruction has the potential to minimize both, motion artifacts and sparse view artifacts while simultaneously making use of 100% of the rawdata [MedPhys 40(10): 101913, 2013]. Irregular breathing, however, still is problematic. In general we have to distinguish between phase and amplitude gating for 4D image reconstruction. Depending on the breathing pattern less motion blurring emerges in amplitude-gated images than in phase-gated reconstructions. However motion estimation based on amplitude-gated images is not always realizable especially for non-cyclic breathing pattern or when strong variation of the breathing amplitude occurs during the image acquisition. This is also, because the procedure of amplitude gating is not well defined. We propose a hybrid MoCo approach that starts with a robust phase gating procedure for the initial motion vector field (MVF) estimation and switches later to an adapted amplitude gating method. This switching implies a resampling of the MVF to make them become amplitude-specific. Our MVF resampling method ensures that the MVFs, that have been estimated based on phase-gated reconstructions, are still valid for all amplitude-gated images. To validate the method we use an artificially deformed clinical CT scan with adaptive breathing pattern and several patient data sets acquired with a TrueBeam™ 4D CBCT system (Varian Medical Systems).

RESULTS

The MVF resampling-based hybrid 4D CBCT MoCo algorithm is able to significantly reduce motion blurring. This is visible in phantom and patient data especially for irregular breathing patterns. Our sharpness metric, measuring the slope of profiles normal to anatomical borders, improved by up to 8%, depending on breathing pattern, acquisition parameter and anatomical feature.

CONCLUSION

Resampling MVFs from phase- to amplitude-gating helps to improve the image quality of MoCo reconstructions in particular for rather irregular breathing patterns. Thus, the new method increases the robustness of motion estimation with CBCT.

CLINICAL RELEVANCE/APPLICATION

Improved motion estimation from CBCT images potentially allows for more accurate tumor tracking.

SSE21-05 Effect of Flat and Curved System Geometry on X-Ray Scatter Distribution and Selection of Antiscatter Grids

Monday, Nov. 27 3:40PM - 3:50PM Room: S403A

Participants
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PURPOSE

System geometries for cone-beam CT (CBCT) vary broadly according to clinical requirements, with strong implications for the magnitude of x-ray scatter and selection of antiscatter grid. This work analyzes such effects for a range of geometries, including curved configurations of the detector and grid that support increasingly compact system design.

METHOD AND MATERIALS

Scatter was estimated using a Monte Carlo (MC) engine with system geometry ranging from long (SDD = 1000 mm) to compact (SDD = 500 mm) for a broad range of grid / detector curvatures. We considered a 41 x 33 cm2 detector with 0.6 mm CsI scintillator and focused antiscatter grids with grid ratio ranging from 6:1 to 10:1 (all 1.25 lp/mm). Scatter distributions (3.6x1011 photons over

360 projections) were computed using a voxelized anthropomorphic head (0.5 mm voxels) containing a skull and heterogeneous brain with soft-tissue contrast up to 60 HU. Scatter estimates were denoised with a 6x6 mm2 Gaussian kernel. Primary fluence was computed with a polychromatic Siddon projector. Poisson noise was added to the total signal with dose fixed at 25 mGy at isocenter. CT volumes were reconstructed using a PWLS approach with a Huber penalty.

RESULTS

For longer system geometries, differences in scatter among curvatures were negligible. For the most compact geometry, the average magnitude of scatter increased up to 23% for the strongest curvature compared to a flat configuration. Interestingly, the increased scatter at the periphery of the field of view resulted in a more uniform SPR distribution and reduced cupping (80 HU cupping vs 115 HU for flat configurations). Antiscatter grids performed similarly for all scenarios up to GR = 8:1, beyond which gains were minimal. Using an 8:1 grid improved soft-tissue CNR from 0.85 to 1.56 for the long flat geometry and from 0.59 to 1.25 for the compact curved geometry.

CONCLUSION

MC provides guidance to selection of geometry, detector curvature, and antiscatter grid for increasingly compact CBCT configurations. Compact designs exhibited larger scatter magnitude but showed comparable performance using a knowledgeable chosen antiscatter grid.

CLINICAL RELEVANCE/APPLICATION

Understanding the effects of x-ray scatter in novel compact CBCT systems improves system design and guides the development of systems with improved image quality.

SSE21-06 Comparison of a Novel Two-Dimensional Antiscatter Grid Prototype with a Conventional Antiscatter Grid in CBCT

Monday, Nov. 27 3:50PM - 4:00PM Room: S403A

Participants
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CONCLUSION

2DASG can provide improved soft tissue visualization with respect to existing CBCT systems that employ conventional 1DASGs. With improved CT number accuracy provided by 2DASG, quantitative imaging applications may be enabled in CBCT based imaging modalities.

Background

A novel 2D antiscatter (2DASG) grid prototype was developed for flat panel detector (FPD) cone beam computed tomography (CBCT) systems, which aims to improve both quantitative accuracy and soft tissue visualization. A 2DASG prototype was fabricated by using scalable powder bed laser melting additive manufacturing process, and employed in Varian TrueBeam CBCT system. Gantry angle specific flat-field correction and a novel total variation minimization method were implemented to remove 2DASG's septal shadows. CBCT images were reconstructed using a modified FDK algorithm. A Catphan phantom and an annuli mimicking abdomen/pelvis anatomy was employed in imaging experiments. CT number accuracy and contrast to noise ratio (CNR) were assessed. Using the same imaging setup, a conventional ASG (1DASG) with 1D lead lamellae, fiber spacers and a grid ratio of 10 was evaluated, and compared to the 2DASG prototype.

Evaluation

Hounsfield Unit (HU) accuracy was measured across multiple ROIs located in the uniform sections of the Catphan phantom. With 1DASG HU values were underestimated by 300±43 HU. With 2DASG, HU underestimation was reduced down to 43±15 HU. With 1DASG, CNR in 3 inserts were 2.0, 2.892, and 14.2, respectively. With 2DASG, CNR was further increased to 3.2, 3.3, and 18 at the same material inserts.

Discussion

2DASG prototype showed significant improvements in CT number accuracy, and contrast resolution when compared to 1DASG and NOASG. Shading artifacts commonly observed in CBCT images were diminished with 2DASG. Additionally, gantry angle specific flat field correction and our novel total variation minimization approach successfully reduced 2DASG's footprint in projections and artifacts in CBCT images.

SSE22

Physics (Radiation Therapy and Cancer Imaging)

Monday, Nov. 27 3:00PM - 4:00PM Room: S403B

OI PH RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Rebecca M. Howell, PhD, Houston, TX (*Moderator*) Nothing to Disclose
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Sub-Events

SSE22-01 Prediction of Clinical Target Volume for Nasopharyngeal Carcinoma Using Hidden Markov Model Trained from 2000 Patient Dataset

Monday, Nov. 27 3:00PM - 3:10PM Room: S403B

Participants
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PURPOSE

Radiotherapy is one of the efficient routine treatment for nasopharyngeal carcinoma (NPC). Clinical target volume (CTV) of NPC, which not only contains gross tumor volumes (GTV) can be seen on scan images like CT or MRI, but also contains underlying irregular tumor region due to tumor invasion. Accurate delineation of CTV takes an essential role on assisting doctors to determinate the radiation dose and the range of exposure. It is noteworthy to point out that the delineation of CTV is time-consuming with about 4-6 hours/case, just for an initial treatment plan. Therefore, in order to develop an automatic delineation method for CTV, we design a new CTV prediction model for NPC, which can predict the tumor expansion and accurately compute tumor invasion probability.

METHOD AND MATERIALS

Our model includes two parts: Hidden Markov Model (HMM) and rule-based learning. HMM is employed in simulating three-dimensional tumor expansion. By computing transition probability between adjacent voxels from GTV iteratively, probability map is generated. Associate rules learned from large-set clinical data, which is able to discover interesting relations in dataset, is used to quantify the spread trend among tiny tissues. We collected 2000 patient's NPC patient data with IRB approval, which are used for training dataset. Each patient data contains a series of GTV contours that are manually annotated by experienced doctors. All GTV contours have been uniformly registered on CT templates. For model evaluation, 50 NPC patients was independently collect. Dice similarity coefficient (DSC) was used to compare computerized model with the reference standard.

RESULTS

In current clinical practice, the assessment time of CTV is between 4-6 hours. Our automated tool took less than 5 minutes to assess the CTV. We compute 50 patients' CTV1 and CTV2 for evaluation, which represent 10% and 5% invasion probability respectively. The average DSC between two radiologists was 0.81 while the average DSC of radiologists and computer was 0.80.

CONCLUSION

This model is applied successfully for the prediction of NPC CTV and can be easily used for other types of tumor. Our automated tool greatly reduces the total time by 48-72 times compared to clinical doctors.

CLINICAL RELEVANCE/APPLICATION

Our NPC CTV prediction model is very useful in radiotherapy treatment, not only reduces the workload of radiotherapists but also provides a more objective way for CTV prediction.

SSE22-02 Considerations and Experience in Lung Treatment with SBRT+DIBH in Arms-down Position

Monday, Nov. 27 3:10PM - 3:20PM Room: S403B

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ABSTRACT

Purpose/Objective(s): Many elderly and frail patients are unable to tolerate the arms-up position for extended periods. This creates a significant challenge for certain types of radiation treatment, such as lung SBRT. Although the arms-up position provides maximal freedom for optimal beam placement and avoids dose to arms, frequent involuntary arm movement can cause significant target displacement and adversely impact dosimetry. This phenomenon is further amplified for lung SBRT+DIBH treatment. The combined modality paradigm prolongs treatment time dramatically when delivered on a machine without FFF beams. From the perspective of treatment accuracy, patient comfort level and stability are crucial for the precision of any immobilization device and on-board imaging system. In this study, we investigated a technique to treat lung patients with SBRT+DIBH in the arms-down position. Our objective was to determine whether the arms-down position could produce a plan dosimetrically comparable to that for the arms-up position. Materials/Methods: A 92-year-old patient was diagnosed with lung cancer of the right lower lobe. The patient was simulated supine on a reversed wide prostate board with arms by sides and palms up under buttocks. Both arms were positioned tightly against the body for stability and reproducibility. A custom Aquaplast body mask was fabricated with an opening cut around the xyphoid process of the sternum for placement of an RPM gating block. A free-breathing CT scan was acquired first for patient marking, followed by a DIBH scan for treatment planning. The patient was treated with SBRT+DIBH protocol with a prescription dose of 1200 cGyx4. A VMAT plan was computed using 6X photon beams. To achieve acceptable PTV conformity and coverage, the plan used six partial arcs. To improve patient comfort during treatment, all six arcs were short and low in MU so that each arc could be delivered in two DIBH sessions. Results: We found that with a well-designed optimization strategy and a proper arc arrangement, the arms-down plan was dosimetrically comparable to the arms-up plan in terms of PTV coverage and OAR sparing. For this case, the right arm was only 3.4 cm away from the PTV. To create a sharp dose gradient, it was contoured and constrained during optimization, achieving PTV D95 = 100% without out-of-PTV hot spots. The maximum dose to the right arm was 1673.6 cGy, with a mean dose of 93.2 cGy. Other dosimetric parameters also met our institutional tolerances. By using multiple short arcs, the MU of each arc was significantly reduced, thus, favorable for DIBH treatment. The MUs were 527, 531, 434, 468, 406, and 409, respectively.Conclusion: Under special circumstances, the arms-down position is a safe and effective way to treat lung cancer patients. The central issue using this approach is determining how to securely confine the arms to minimize TMR perturbation. VMAT is relatively insensitive to small variations in arm position. The arc smearing effect will compensate for uncertain TMR.

SSE22-03 RTOG3507: A Multi-Institutional Planning Comparison Study to Determine the Feasibility of a Randomized Study of Pembrolizumab Plus Stereotactic Re-Irradiation versus SBRT Alone for Locoregionally Recurrent or Second Primary Head and Neck Cancer

Monday, Nov. 27 3:20PM - 3:30PM Room: S403B

Participants
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Si Young Jang, PHD, PITTSBURGH, PA (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): RTOG foundation will soon open a randomized phase II study to evaluate the safety of the addition of Pembrolizumab to re-irradiation with SBRT for patients with recurrent or new second primary head and neck carcinoma (CA). This is the first multi-institutional study that involves SBRT of head and neck cancer. Treatment planning requirements for this study are very stringent. Therefore, it is important to determine the feasibility of performing such a study in a multi-institutional clinical trial setting. The goal of this study was to evaluate whether cancer centers around the country can generate protocol compliant treatment plans for challenging locoregionally recurrent or second primary head and neck carcinoma test cases. Materials/Methods: Five challenging test cases were circulated among five institutions and each of the institutions was asked to generate treatment plans according to protocol guidelines. The cases investigated were all recurrent tumors including: 1) A squamous cell CA of the oral tongue located very close to the skin, 2) A squamous cell CA of the right base of tongue located at lower neck 3) A recurrent tumor of the oropharynx close to mandible, 4) A recurrent tumor of left neck located near spinal cord, and 5) A recurrent tumor located in right maxillary sinus. PTV volumes ranged between 27cc and 95cc. Static IMRT or VMAT techniques with a calculation grid size of = 2mm were used for dose calculation. The RX dose was 40Gy in five fractions. Treatment plans were normalized to the maximum dose of the plan in which 100% of the isodose line corresponded to. The prescription isodose line encompassed at least 99% of the GTV and 95% of the PTV and ranged between 80% and 90%.Results: The protocol provided specific guidelines for compliance for GTV_4000, PTV_4000, and various organs at risk such as spinal cord, brain stem, optic nerve/chiasm, brachial plexus, carotid artery, esophagus, skin, and dose spillage. The GTV and PTV coverages were found to be over 99% and 95% respectively for all institutions, and doses for various organs at risk were mostly within the protocol specifications: mean values of maximum cord, cord+5mm, and brain stem doses were 7.0Gy, 9.3Gy, and 4.1Gy, respectively; mean values of conformity index, R50%, and D2cm for all multi-institution plans were 1.1, 4.0, and 26.1Gy, respectively; however, some institutions could not meet protocol guidelines for skin dose for the case abutting with the skin and for carotid dose for the case located inside the target (skin: =30Gy, carotid artery: =42Gy). Conclusion: This multi-institutional study shows that it is feasible for centers around the country to meet protocol requirements when generating SBRT treatment plans for challenging recurrent and second primary head and neck carcinoma.

SSE22-04 Dosimetric Uncertainty of Homogeneous Dose Calculation in Lung SBRT Patients with Low Lung Density

Monday, Nov. 27 3:30PM - 3:40PM Room: S403B

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ABSTRACT

Purpose/Objective(s): For patients with low lung density, the lack of equilibrium and insufficient dose build-up may cause significant deviation from planned dose distributions if heterogeneous tissue is assumed to have water density. It is hypothesized that significant dosimetric variations may happen in peripheral lung SBRT cases using the RTOG protocols of 60 Gy in 3 fractions with homogenous dose calculation compared to a recalculated plan with heterogeneity corrections for patients with low lung density.Materials/Methods: The patient selection process narrowed down a group of 120 patients previously treated to 60 Gy in 3 fractions to patients with the twelve lowest (below -813 HU) and the twelve highest (above -657) lung density. For each patient, a 5 mm expanded internal target volume (ITV) represented the planning target volume (PTV). Additional ring structures were created by expanding the PTV (PTV ring) and ITV (ITV ring) by 1 cm to analyze the surrounding tissue density and Hounsfield Unit (HU) values. VMAT plans consisting of two coplanar half arcs were made for each patient without heterogeneity corrections. The clinically acceptable, optimized plan met several organs at risk (OAR) dose limits and the following planning goals: PTV V60Gy = 95%, PTV V54Gy = 100%, ITV V60Gy = 100%. Finally, the monitor units were held constant and the plan was recalculated with the original heterogeneous tissue densities from the image set using collapsed cone convolution algorithm. Results: Low Density High Density Mean HU Mean density (g/cm3) Mean HU Mean density (g/cm3) Lung -838 ± 21 0.20 ± 0.03 -613 ± 27 0.45 ± 0.03 RingPTV -774 ±107 0.26 ± 0.11 -478 ± 53 0.57 ± 0.05 RingITV -789 ± 93 0.25 ± 0.09 -562 ± 51 0.49 ± 0.04 Table 1. The mean Hounsfield Units (HU) for the 120 patient pool was -728 ± 69 HU (range: -875 – 557 HU). Results of this study showed that planning goals were not met for patients with low lung densities when dose calculation was completed using heterogeneous tissue densities. The PTV V60Gy goal of 95% dropped significantly to a mean of 76.9% ± 17.2% for patients with low lung density (range: 43.3% - 96.2%) while the patient group with high lung density met planning goals with a mean of 96.1% ± 3.0% (range: 88.5% - 99.9%) (p = 0.004). After the dose calculation with heterogeneity corrections, respectively for the low and high lung density patients, the mean V54Gy was 95.5 ± 5.7% (81.0% - 99.8%) and 99.9 ± 0.1%, p=0.01; the mean ITV V60Gy was 99.4 ± 1.1% (96.3 – 100.0%) and 100.0 ± 0.02% (99.9 -100.0%), p = 0.06. The decrease in PTV 60Gy for the low lung density patients correlated better with RingITV (r = 0.71). The results were not correlated with the lung density or HU. Conclusion: The dosimetric variations were significantly large for patients with very low lung density compared to high lung density. It may be beneficial to evaluate patient lung density for SBRT plans following protocols that require homogeneous dose calculation.

SSE22-05 A Non-Uniform and Non-Coplanar VMAT Dose Delivery Markedly Reduces Lung Dose in Lung SBRT

Monday, Nov. 27 3:40PM - 3:50PM Room: S403B

Participants
Jens Fleckenstein, Mannheim, Germany (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): In this retrospective treatment planning study, the effect of different formalisms of prescribing dose to a target volume (PTV)- a uniform and a non-uniform PTV coverage and volumetric modulated arc therapy (VMAT) dose delivery options – a coplanar and a non-coplanar delivery approach- for lung lesions treated with stereotactic body radiation therapy (SBRT) were compared.Materials/Methods: Treatment plans for 46 lesions in the peripheral lungs (VPTV 20.5±17.5cm³, VPTV,min 3.8 cm³, VPTV,max 85.4 cm³) were generated. The D95%(PTV) was 60Gy, delivered in 5 fractions. For each patient three different treatment plans were generated:First, a coplanar 360° VMAT treatment plan with a uniform dose prescription in the target. The planning objective was to cover all voxels in the PTV with 95%-107% of the prescription dose (in agreement with ICRU report 50). Second, a coplanar 360° VMAT treatment plan with a non-uniform dose distribution. The dose in the PTV was limited to a maximum of 150% of the prescription dose as proposed in RTOG trial 0915. Third, a non-coplanar VMAT dose delivery from four different couch angles (0°, ±35°, 90°) combined with a non-uniform PTV prescription as described above was used.All treatment plans were optimized with the described PTV coverage with as low as achievable dose to the lungs. Dose calculation was performed with a clinically commissioned, Monte Carlo based treatment planning system. The treatment sequences were delivered on a conventional medical linear accelerator with flattening-filter-free (FFF) dose delivery and 10MV nominal acceleration potential and the beam-on times were recorded.Results: For the three different scenarios (uniform coplanar, non-uniform coplanar, non-uniform non-coplanar) the delivered monitor units (MU) were (5141±117) MU, (4104±786) MU, and (3657±710) MU, and the corresponding beam-on times were (177±54)s, (143±29)s, and (148±26)s, respectively. This resulted in the following median dose-volume-histogram metrics for PTV, ipsilateral (ILL), and contralateral lung (CLL): uniformcoplanarnon-uniform coplanarnon-uniformnon-coplanarD99%(PTV) in (Gy)58.657.456.8D50%(PTV) in (Gy)62.769.568.4D1%(PTV) in (Gy)66.778.984.1V>5Gy(ILL) in (%)24.820.920.9V>10Gy(ILL) in (%)15.613.410.9V>20Gy(ILL) in (%)6.36.14.2V>30Gy(ILL) in (%)2.82.62.0V>40Gy(ILL) in (%)1.41.21.0V>5Gy(CLL) in (%)3.20.50.3All presented dosimetric results and dose to volume differences between (uniform, coplanar and non-uniform, non-coplanar treatment plans are significant (pConclusion: For SBRT treatments, a non-uniform dose prescription in the PTV, combined with a non-coplanar VMAT arc arrangement, significantly spares surrounding lung tissue while increasing the dose to the PTV.

SSE22-06 ZnS:Ag Scintillator as a Quality Assurance Tool for Scanned Carbon Ion Therapy

Monday, Nov. 27 3:50PM - 4:00PM Room: S403B

Participants

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CONCLUSION

We tested a ZnS:Ag scintillator as a QA tool for carbon ion therapy. The tool showed potential as a quick, precise way to measure the depth and lateral dose profiles of carbon pencil beams.

Background

Recently, quick and accurate measurement of dose distribution is essential for quality assurance (QA) of treatments with scanned carbon pencil beams. We developed an easy-to-use dose measurement tool that employed a ZnS:Ag scintillator and charge-coupled device (CCD) camera. One of the challenges in dose measurement of pencil beams for clinical use is the precise measurement of the lateral dose profile, including the low-dose envelope. We tested the tool's performance using pencil beams, comparing the depth and lateral brightness profiles with the dose profiles.

Evaluation

A sheet of the ZnS:Ag scintillator was placed perpendicular to the beam axis in a dark box to eliminate any background light. The water level of the tank above the dark box was controlled remotely to adjust the measurement depth. The scintillation light produced by irradiation with a carbon ion beam was reflected with a mirror and was recorded with a CCD camera; 290 MeV/nucleon mono-energetic carbon pencil beams were used. The depth and lateral brightness distributions from the scintillator were compared with the dose distribution, which was measured with an ionization chamber and a diode.The brightness of the ZnS:Ag scintillator was proportional to the dose (0.5-3 Gy). The depth brightness profile measured with the scintillator was underestimated by about 12% at the Bragg peak, compared with the depth dose profile measured with the chamber. Lateral brightness profiles at the entrance depth showed good agreement with the relative dose profiles measured with the diode. In contrast, there was a discrepancy of over 40% at the Bragg peak.

Discussion

In future, improvement of the signal-to-noise ratio of lateral brightness profiles at the Bragg peak, including the low-dose envelope will be necessary.

SSE23

Physics (Image Processing and Image Quality)

Monday, Nov. 27 3:00PM - 4:00PM Room: S404AB

PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 0

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Sub-Events

SSE23-02 Effect of Motion Compensation on the Image Quality of Cone Beam CT Scans in Musculoskeletal Setting

Monday, Nov. 27 3:10PM - 3:20PM Room: S404AB

Participants
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PURPOSE

To assess whether motion compensation (MC) applied to musculoskeletal cone beam CT (CBCT) images would demonstrate improved image quality and superior diagnostic value.

METHOD AND MATERIALS

18 study participants (13 male 5 female, average age 32 years) who underwent cone beam CT imaging and had motion artifacts in their scans were retrospectively selected. Image datasets were reconstructed using a recently developed motion compensation algorithm. The algorithm uses an "autofocus" approach that numerically estimates the motion trajectory by maximizing the sharpness of the reconstructed image. Image quality was graded using a 5-point Likert scale (1 and 2 non diagnostic, 5 excellent) by two experienced readers in consensus for cortical bone, trabecular bone, joint space, patellar tendon and severity of artifact. Data was analyzed using Visual Grading Characteristics (VGC) curve analysis. Artifact magnitude was quantified as the standard deviation in a soft-tissue region adjacent to bone and centered on the most prominent hyperattenuating streak artifact.

RESULTS

The amplitudes of patient motion, as estimated by the compensation algorithm, varied from 2.3 mm to 8 mm (mean=5.6 mm). All 18 datasets improved in image quality from non-diagnostic (ratings 1 and 2) in original CBCT images to diagnostic (ratings 4 and 5) in MC CBCT images for cortical and trabecular bones. All visualization tasks were significantly in favor of the MC CBCT (Area under curve 0.75 to 0.89, for all tasks). Quantitatively, the artifact magnitude was reduced from 230 HU (min=94 HU, max=334 HU) before compensation to 150 HU after MC.

CONCLUSION

MC improved the image quality of CBCT scans rendered non-diagnostic by motion artifact. The correction was more significant in bone as compared to soft tissue structures.

CLINICAL RELEVANCE/APPLICATION

As the scan times for CBCT examinations are usually longer than conventional CT (~30 sec. vs ~1 sec.), the likelihood of motion artifacts is increased in CBCT. This motion compensation algorithm has, therefore, the potential to be a valueble tool in growing use of dedicated musculoskeletal CBCT imaging.

SSE23-03 Algorithm and Parameter Optimization for Whole-Body Deformable Registration between MR T1-Weighted and Dixon Images (for PET/MR)

Monday, Nov. 27 3:20PM - 3:30PM Room: S404AB

Participants
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PURPOSE

While whole-body MR T1-weighted (T1W) and Dixon images can provide diagnostic and localization information at high spatial resolution for PET/MR interpretation and attenuation correction, the images may be misregistered in lung and upper abdomen due to respiration and patient motion which cannot be corrected using rigid-body registration. To address this, we developed a fully automatic deformable registration with algorithm optimization.

METHOD AND MATERIALS

Six whole-body MR Dixon and T1W data sets were collected (Philips Ingenuity TF PET/MR). Having the highest spatial resolution, the Dixon in-phase images were treated as reference for the registration. Rigid-body registration was first performed. Then, an open-source application, REGGUI, was used for non-gradient-based deformable registration. The optimal method was chosen among block-matching (BD), sum of square difference (SSD), BD-SSD with gradient, and local phase algorithms. In addition, a pre-regularization and a fluid regularization with different filters and parameters was applied and optimized for the best performance. SSD, mutual information (MI), normalized MI (norMI) and correlation coefficient (R) were recorded at the end of each iteration for performance evaluation.

RESULTS

The deformed whole-body T1W images were aligned with the Dixon images, especially in the areas of lung, liver, and upper abdomen. The local phase deformable algorithm shows the best result among the four methods. The pre- or fluid- regularization filters did not improve the registration. The majority of the mismatch between original T1W and Dixon images was from the deformation of lung and organs due to different breathing techniques and can be reduced with the deformable registration. This whole-body registration is insensitive to the change of the parameters and do not require filtering. The deformable registration currently takes 1 h but can be automated for clinical practice until computational optimizations are implemented.

CONCLUSION

The automatic registration with whole-body T1W and Dixon images are feasible using non-gradient-based deformation. The local phase without regularizations shows the best performance for this whole-body deformable registration.

CLINICAL RELEVANCE/APPLICATION

This study established a clinical practicable approach for an automatic deformable registration between whole-body T1W and Dixon images.

SSE23-04 A Viewer for Dynamic Whole-Body PET/CT Studies with Integrated Voxel-based Patlak Analysis

Monday, Nov. 27 3:30PM - 3:40PM Room: S404AB

Participants
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PURPOSE

The purpose of our project was to develop a software system for the display, quantitation and voxel-based Patlak analysis of dynamic whole-body PET/CT imaging studies.

METHOD AND MATERIALS

We developed a DICOM image viewer and analysis system in the Java programming language. The viewer can load dynamic (multi-timepoint) DICOM whole-body image sets as well as aggregating separately acquired whole body image series. In addition, the viewer can load any co-registered anatomical imaging (e.g. CT, MR) for fusion display and anatomical localization, employing multiple look-up tables and user control of image blending. We incorporated regions-of-interest (ROIs) which provide real-time display of Time-Activity-Curves (TACs) and corresponding image statistics. For the voxel-by-voxel Patlak analysis, ROIs are used to provide the necessary input function data, either providing the entire function if imaging captures the time of injection, or used to scale a population input function when only later imaging timepoints are available.

RESULTS

Integrated PET/CT display of dynamic whole-body PET was provided, allowing user navigation of study time points in a similar fashion to conventional clinical image review. In addition to providing simple navigation of fused datasets across all timepoints, the system provided for the generation of summed image datasets, as well as the generation and display of Patlak slope, intercept and correlation images resulting from a voxel-based Patlak analysis. ROIs drawn on any one dataset were dynamically applied to any other dataset, providing real-time TACs across both original and derived images. Tabular ROI statistics from any dataset are exportable for further analysis.

CONCLUSION

Modern PET/CT scanners are faster and more efficient than ever before, enabling dynamic whole-body acquisitions which previously were not feasible. The software presented here provides many of the required features to properly display and analyze these new datasets, and does so in an implementation which is easily navigable by the user and executable on the widest variety of computing platforms.

CLINICAL RELEVANCE/APPLICATION

Dynamic whole-body PET/CT imaging is possible and, when provided with the right toolset, clinicians can begin to exploit the additional dimension of information which this imaging strategy provides.

SSE23-05 Novel Approach to Estimate Source-Detector Alignment of Cone-Beam X-Ray Systems Using Collimator Edge Tracking

Monday, Nov. 27 3:40PM - 3:50PM Room: S404AB

Participants
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PURPOSE

Due to upcoming applications for clinically well-established digital X-ray systems, like workflow automation or high-quality free exposures with mobile detectors, knowing and reproducing the exact source-detector alignment is a crucial factor. Hence, it is important to determine their exact alignment without complicating the clinical routine or adding any additional hardware. Furthermore, novel X-ray systems with independently moveable source and detector might benefit from this method.

METHOD AND MATERIALS

The presented method utilizes the fact that the position of the collimator relative to the source is known, and determines the intrinsic parameters of a projection matrix using a two-staged algorithm.1. Detect the corners of the collimator in the projection image and find a preliminary set of intrinsics such that the difference between the projection of the known 3-D collimator coordinates and the detected corners is minimal in a least-squares sense.2. Use these intrinsic parameters as initial values for an optimization, to find the optimal set of intrinsics (f, u0, v0) which maps the 3-D coordinates best to the 2-D ones on the detector, by maximizing the sum along the line integral between the projections of two collimator corner points using a precomputed gradient magnitude image.For validation, a simulation study was carried out, simulating the projection of the collimator, taking the introduced blurring due to the focal spot size into account. In total, 27 data sets (2880x2880 px á 0.15 mm, f = 1200 mm) with various detector rotations and translations were simulated and used for evaluation. Each variable was then compared to the ground truth separately.

RESULTS

It was shown that the presented method is able to estimate the detector offset (u0, v0) with an accuracy of ±1.35 px and the focal length f with an accuracy of ±5 mm.

CONCLUSION

The presented algorithm is capable of estimating the source-detector alignment of cone-beam X-ray systems, utilizing only already existing information of the X-ray system. Thus, this method might enable new clinical applications which could lead to a benefit in the clinical routine.

CLINICAL RELEVANCE/APPLICATION

The proposed method might open up the possibility of further workflow automation and image quality improvement in well-established digital X-ray systems. Additionally, emerging technologies like CBCT using robotic devices might profit.

SSE23-06 Feasibility Study of the NPWE Model Observer for Objective Image Quality Assessment of Processed Digital Mammography Images

Monday, Nov. 27 3:50PM - 4:00PM Room: S404AB

Participants
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PURPOSE

To investigate how image processing algorithms in digital mammography affect the detectability of calcification-like discs embedded in an anthropomorphic breast phantom for both human and model observers.

METHOD AND MATERIALS

A 3D printed phantom was constructed from a patient breast CT image, and cut into two transverse slabs. Between the slabs, aluminum squares with gold discs of 0.1 mm and 0.25 mm diameter (1.80 µm and 0.50 µm thick) were inserted. Images were acquired at four dose levels using two mammography systems, and images with and without processing were used to create 200 signal-present and 200 signal-absent regions of interests (ROIs) per system type, image type, dose level and disc size. The ROIs were scored by a non-prewhitening with eye-filter (NPWE) model observer and by three human observers in two-alternative-forced-choice experiments. As a measure of performance, the proportion of correct (PC) responses was obtained.

RESULTS

For system A, for the 0.1 mm discs, PCNPWE increased with dose and ranged from 0.74-0.89 and 0.75-0.92 (p=0.12); PCH varied 0.73-0.93 and 0.71-0.95 (p=1), in case of ROIs with and without processing respectively. Similar results were obtained for the 0.25 mm discs and for both disc sizes on system B. The correlation between humans and model observer was high and resulted in R2=0.77 for the 0.1 mm and R2=0.85 for the 0.25 mm disc. As expected, all PC values increased with dose and trends were similar for both systems and unprocessed/processed images.

CONCLUSION

For the task of detecting a specific disc size, model and human observers have a consistent correlation in PC in images with and without processing under different conditions (dose levels, type of system). Therefore, an NPWE model observer and real acquired images of a realistic breast phantom could be used in the assessment of detection of calcification-like discs in images including image processing

CLINICAL RELEVANCE/APPLICATION

Model observers and anthropomorphic phantoms could be used to assess the impact of image processing algorithms on lesion detectability, allowing for task-based testing of this important post-acquisition stage.

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SSE24

Radiation Oncology (Breast)

Monday, Nov. 27 3:00PM - 4:00PM Room: S104A

BR RO OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Jianling Yuan, MD, PhD, Minneapolis, MN (*Moderator*) Nothing to Disclose
Kathleen Horst, MD, Stanford, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSE24-01 Effectiveness and Accuracy of Novel 3-D Surgical Markers in Identifying Post-Surgical Boost Cavities in Women with Early Stage Breast Cancer for Adjuvant Radiation Therapy

Monday, Nov. 27 3:00PM - 3:10PM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): For patients undergoing breast conserving surgery (BCS), adjuvant radiation therapy (RT) is the standard of care. A lumpectomy cavity boost (LCB) is typically added for patients with high risk features such as young age, lymph node positivity, positive margins, and the use of neoadjuvant or adjuvant chemotherapy. Defining the boost volume is traditionally guided by the post-operative seroma, anatomical landmarks, and surgical clips; however, there can be much discrepancy in defining these cavities. This ambiguity may result in over or underestimation of the cavity's true size, especially in the setting of oncoplastic reduction (OR) or a delay between surgery and adjuvant RT. The accurate delineation of the cavity volume will determine the high dose RT boost volume, which can in turn impact breast toxicity. This study seeks to evaluate whether the use of a novel 3-D implantable tissue markers (TM) will decrease ambiguity in the delineation of the surgical cavity and result in more accurate LCB volumes. Materials/Methods: The records of 10 consecutive patients (range: 50-71 years) who underwent BCS followed by adjuvant RT with a LCB at our institution between January 2015 and July 2015 were reviewed. Nine (90%) of the LCB were treated using mini-tangents and one (10%) was treated using enface electrons. Five of the patients underwent BCS alone and 5 underwent BCS and OR. All patients had 3-D TM placed at the time of surgery. Two independent radiation oncologists determined the LCB volumes, one using the traditional indicators such as seroma size and surgical clips, while the other defined the cavity using 3-D TM. Results: The mean LCB volume using traditional methods was 32.15cc (SD=21.97 and SEM=6.9) and 19.14cc (SD=8.0 and SEM=2.5) using 3-D TM (P=0.072). In the BCS arm, 4 patients (80%) had a reduction in the LCB volume with the use of 3-D TM (range, 8.7%-66.2%). One patient had an increase in their LCB volume with the use of 3-D TM by 25.0%. In the BCS+OR arm, 3 patients (60%), had a reduction in their LCB volume with the use of 3-D TM (range, 50.1%-68.7%) and 2 patients (40%), had an increase in their boost volume (47.6% and 154.8%). Conclusion: On average, LCB volumes were smaller using 3-D TM for planning as compared with conventional methods and locating the lumpectomy cavity was more precise. Although this value did not reach statistical significance with a p=0.072, the trend towards statistical significance, especially with a small sample size, should be noted. In the BCS+OR arm, the use of 3-D TM resulted in significant reductions in treatment volumes in 3 cases, while also helping to increase the necessary LCB volume in 2 patients that would have otherwise been undertreated. The 3-D TM appeared to be more effective at identifying and maintaining the cavity for boost determination, especially in those with OR. This study is hypothesis generating and will serve as a report to initiate future studies examining the local control and toxicity rates of patients receiving LCB with 3-D TM versus conventional methods.

SSE24-03 Bolus Technique in Post-Mastectomy Radiotherapy: Practice Patterns and Acute Toxicity Outcomes

Monday, Nov. 27 3:20PM - 3:30PM Room: S104A

Participants
Adam C. Ferro, MD, MS, Baltimore, MD (*Presenter*) Nothing to Disclose
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Fariba Asrari, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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Todd R. McNutt, PhD, Baltimore, MD (*Abstract Co-Author*) Research collaboration, Koninklijke Philips NV Research collaboration, Toshiba Corporation Research collaboration, Elekta AB

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ABSTRACT

Purpose/Objective(s): While bolus is commonly used to enhance dose to superficial tissues in post-mastectomy radiotherapy (PMRT), there is little consensus regarding its specific indications or optimal use. We review practices patterns of bolus application following mastectomy across four facilities with expertise in breast radiotherapy.Materials/Methods: Medical records were reviewed for all patients who were managed with PMRT between 9/11/2007 and 12/31/2016. Treatment fields and bolus factors were recorded, and the association between bolus type by reconstruction status of the chest wall (unreconstructed vs. reconstructed) was assessed by Chi2 analysis. Acute radiation-related toxicities were evaluated by the treating physician during the course of PMRT; scores at baseline and at the final assessment were compared. Logistic regression assessed for the odds of acute toxicity outcomes by bolus status. We additionally evaluated the odds of completing scar/surgical bed boost by bolus status. Results: A total of 316 patients received PMRT during the study period. The chest wall was unreconstructed in 38%, reconstructed including with tissue expander in 51%, and unspecified in 11% of cases. Additional fields included dedicated supraclavicular coverage in 85% and scar/surgical bed boost in 41% of treatments. A total of 270 patients had adequate bolus details to analyze. Bolus was used for at least part of the treatment in 75% of unreconstructed chest wall and 61% of reconstructed chest wall PMRT cases, most commonly with brass mesh and 1-cm oil gel sheets, respectively. Use of bolus was significantly higher for the unreconstructed group (p=0.012). Surgical bed boost fields employed bolus in 71% of treatments, and 0.5-1.0 cm oil gel sheet bolus were used 84% of the time. Acute toxicity assessments were available for 151 patients. When controlling for reconstruction status of the chest wall, use of bolus was not significantly associated with worsening odds of acute toxicity outcomes including radiation-related pain, burning, or hyperpigmentation. Also adjust for reconstruction status, the use of bolus did not significantly affect the odds of receiving a scar/surgical boost (OR 1.63, CI 0.95-2.83).Conclusion: These data confirm that bolus is commonly employed in the delivery of post-mastectomy radiotherapy, particularly among patients with unreconstructed chest walls. Although bolus type and duration of use varied, when controlling for reconstruction status of the chest wall, neither acute toxicities nor completion of scar/surgical bed boost were worse with the use of bolus.

SSE24-04 Four Year Follow-Up of Patients Treated With either Accelerated Partial Breast Irradiation or Whole Breast Irradiation in a Community Hospital: Possible Implications for PR Negative Patients

Monday, Nov. 27 3:30PM - 3:40PM Room: S104A

Participants
Imraan Jan, Newark, DE (*Presenter*) Nothing to Disclose
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ABSTRACT

Purpose/Objective(s): This study sought to evaluate the comparative safety of partial breast irradiation vs whole breast radiation in a community hospital setting. The primary endpoint of the study was local control. Secondary endpoints included: toxicities, complications and regional and distant failure rates.Materials/Methods: All patients were selected from the breast surgeons employed by the institution and from the contracted radiation oncology practice. Treatment options were discussed at a multidisciplinary conference and consensus decisions guided by national criteria. Accelerated partial breast irradiation (APBI) patients had their tumor cavity treated with a strut assisted volume implant in 10 fractions of 3.4 Gy administered bid. Contemporary early stage patients (Tis-T2, N0) treated with whole breast (WB) radiation were randomly selected from the same practice. During the period 2008-2014, 219 patients were treated with APBI and 143 were randomly selected from the whole breast patients. As appropriate, Chi Square , Fisher's exact and Log-Rank tests were used to compare categorical data.Results: Ninety-two percent of the patients were seen within a year of review. Mean length of follow up was 3.7 years in WB patients and 3.8 years in APBI. Actuarial local recurrence-free survival was 95% in the WB group at 5 years and 96% in the APBI cohort (NS).The whole breast group had four local failures (LF)-two distant and LFs and two LFs. All LFs were in breast true recurrences (IBTR). Significantly more patients within the WB group had T2, grade 3, or ER negative disease, were likelier to have chemo and less likely to have antiestrogen therapy (p).Only 3 of 219 patients treated with APBI were ER negative. Three of seven LFs were IBTRs, the others elsewhere in the breast. Among all recurrences in the APBI group 7 of11 were ER +, PR - vs 37 of 208 in the patients without recurrence (p=.0015).The APBI group had significantly lower rates of fatigue, dermatitis, and breast pain (5.94%, 26.5%, and 26.5% respectively) compared to the whole breast group (57.6%, 99.3%, and 54.2% respectively) (p).Conclusion: Both APBI and WB patients had comparable and low LF rates, but the pattern of recurrence (NS) and prognostic factors (p) differed, suggesting a possible effect on outcomes of the radiation mode employed.The equality of local control, given the different covariates in these two cohorts, underscores the importance of patient selection and adherence to national guidelines.Acute toxicity was less with APBI.There is a strong suggestion that PR -patients have a worse prognosis for local and distant recurrence than PR + in APBI, despite being ER +. This needs to be confirmed with prospective data.

SSE24-05 Intensity Modulated Proton Therapy For Re-irradiation of Recurrent Cancer in the Breast and Chest Wall: A Single Institution Experience

Monday, Nov. 27 3:40PM - 3:50PM Room: S104A

Participants
Fantine Giap, Dallas, TX (*Presenter*) Nothing to Disclose
Lei Dong, PhD, San Diego, CA (*Abstract Co-Author*) License agreement, Varian Medical Systems, Inc
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ABSTRACT

Purpose/Objective(s): This retrospective study describes a single institution's technique and early experience with Intensity Modulated Proton Therapy (IMPT) for re-irradiation of recurrent malignancies in the breast and chest wall over the past 3 years. Materials/Methods: We identified 10 patients in this category, all of whom had previous radiation to the breast or chest wall. Two patients needed chest wall radiation after resection of recurrent cancer due to positive margins; seven patients had

gross nodal and chest wall recurrence; one patient had post-lumpectomy radiation in previously irradiated area from another malignancy. All patients except one (23.4 Gy) had previous full dose radiation to 50 Gy or higher. Patients, immobilized with either a breast board or Vac-Q-Fix cushion, were set up in the supine position with their arms over their head. One to two beams using IMPT with MFO technique was used. Dose was prescribed at 1.8-2 Gy to 50 to 66 Gy daily treatment. Weekly adaptive simulation was done with CT. Photographs were obtained during and after treatment. All cases were reviewed and approved by our weekly physicist and physician treatment planning conference.Results: All patients had grade 1-2 skin toxicity. There were no Grade 3 or greater acute or late toxicity. One patient developed grade 2 lymphedema. No patients have local failure, and all are still alive.Conclusion: IMPT is feasible and a safe modality for re-treatment of recurrent cancer in the breast and chest wall. Further validation with more patients and longer follow-up is needed.

SSE24-06 Clinical Risk Factors Associated with Improved Relative Survival Among Metastatic Breast Cancer Patients Receiving Palliative Radiation Therapy

Monday, Nov. 27 3:50PM - 4:00PM Room: S104A

Participants
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Nima Harandi, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
John Lee, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Predicting survival of patients with metastatic breast cancer remains difficult. Identifying breast cancer patients with improved relative survival can help identify patients who may benefit from palliative radiation therapy. The aim of this study was to determine clinical factors associated with improved relative survival in metastatic breast cancer patients treated with palliative radiation therapy. Materials/Methods: We identified a cohort of metastatic breast cancer patients in the Surveillance, Epidemiology, and End Results (SEER) dataset from the years 1973-2013. A survival analysis was performed using SEER*Stat software to determine the 5-year expected survival in this cohort of patients using the Ederer II method. Expected survival was based on a non-cancer cohort matched on age, sex, and race. Relative survival was determined as the ratio of observed survival to expected survival. Multivariate logistic regression was performed to identify risk factors associated with improved relative survival. Risk factors analyzed were age at diagnosis, grade, histologic type, presence of metastasis to bone at diagnosis, and status of estrogen receptor (ER), progesterone receptor (PR), and HER-2 receptor.Results: We analyzed 3,356 patients from the SEER database who were diagnosed with metastatic breast cancer and received palliative radiation therapy between 1973-2013. Median survival of the entire cohort was 14 months. Median expected survival was 59 months, and median relative survival was 24.1%. Multivariate logistic regression found younger patients [OR 1.81; 95% CI(1.10, 2.97); p=0.02] with metastatic bone lesions [OR 1.5; 95% CI(1.29, 1.83); p=0.01] to be associated with improved relative survival. Conversely, patients with poorly differentiated [OR 0.68; 95 CI (0.48, 0.96); p=0.03], HER-2 positive tumors [OR 0.70; 95% CI(0.50, 0.97); p=0.03) were found to have decreased relative survival. Histologic type as well as ER and PR receptor positivity did not have statistically significant impact on relative survival.Conclusion: Younger age and the presence of osseous metastatic disease at diagnosis were associated with improved relative survival in patients with metastatic breast cancer who received palliative radiation therapy. Our findings may help physicians identify patients who are mostly likely to benefit from palliative radiation therapy and help inform shared decision making for patients considering multiple palliative treatment options.

SSE25

Vascular Interventional (Vascular and Dialysis Access)

Monday, Nov. 27 3:00PM - 4:00PM Room: N226

VA IR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSE25-01 Poor Man's Thrombectomy for the Treatment of Thrombosed Arteriovenous Grafts: 5-Year Results of 241 Cases

Monday, Nov. 27 3:00PM - 3:10PM Room: N226

Participants
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Stavros Spiliopoulos, MD, PhD, Patra, Greece (*Abstract Co-Author*) Consultant, C. R. Bard, Inc Research funded, C. R. Bard, Inc
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PURPOSE

This was a retrospective analysis investigating the results of a hybrid thrombolysis-thrombectomy method performed in our department for the treatment of thrombosed dialysis arteriovenous grafts (AVG).

METHOD AND MATERIALS

Within 5 years (January 2012-Decmber 2016), 291 declotting procedures were performed in our department for the treatment of thrombosed dialysis arteriovenous fistulas or grafts. Data were available for 129 patients (75 men, 58.1%) with an AVG undergoing 241 procedures [1.87procedures/patient (1-10)]. Procedure includes initial thrombolysis with 5mg rTPA followed by thrombectomy with high pressure balloons for thrombus maceration using "facing sheaths" technique. 61 patients had >=2 declotting procedures. In 80 cases (80/241; 33.2%) a stent graft (SG) was used for thrombus apposition or treatment of persistent stenosis. Primary outcome measure was circuit survival. Secondary outcome measures included procedural complications and investigation of independent factors that could influence survival.

RESULTS

Median survival was 434 days according to Kaplan Meier survival analysis. In 6 cases (6/241, 2.49%) declotting failed and a catheter was placed. There were 16 minor (16/241, 6.64%) and no major complications. There was no significant difference regarding circuit survival when a SG was placed (No SG 406 days vs. SG 349 days; p=0.24). There was a significant difference in favor of the 2nd declotting compared to the 1st in 61 patients (1st: 162 days vs. 2nd: 447 days; p<0.0001).

CONCLUSION

Hybrid declotting method performed in our department has high survival rates with increased technical success and minimum complications without the use of thrombectomy devices.

CLINICAL RELEVANCE/APPLICATION

A hybrid thrombectomy - thrombolysis method for the treatment of thrombosed AVGs

SSE25-02 Is Preprocedural Bloodwork Necessary in Children Undergoing Elective Removal of Tunneled Central Venous Access Devices (cVLs)?

Monday, Nov. 27 3:10PM - 3:20PM Room: N226

Participants
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Bairbre L. Connolly, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose
Joao G. Amaral, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose

Philip R. John, MBBCh, FRCR, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Obtaining pre-procedural bloodwork in paediatric patients is often a traumatic and stressful experience for the patient as well as adding extra cost and time penalties to a busy interventional procedural list. We assessed the utility of preprocedural complete blood counts (CBC's) and coagulation screens with respect to intraoperative and postoperative bleeding complications for all patients undergoing elective removal of CVL's to see if the preoperative blood work could safely be eliminated without affecting patient safety.

RESULTS

A total of 1112 cases were identified. 865 devices were removed electively of which 843 had pre-procedural bloodwork. The average patient age was 8.47years and the average patient weight was 16.6kg. 35 patients were under 10kg. 116 cases had a personal history of a bleeding disorder. The average Hb, PT, INR and PTT were 126.7, 270.6, 1.07 and 32.1 respectively. 102 cases had documented abnormal pre-procedural bloodwork. Of these 14 cases had pre-procedural treatment initiated on the basis of the blood results. 5 cases had Factors given, 6 had platelets and 3 had FFP. 96% of cases were documented as uneventful. The 4% of cases described as eventful required a second dissection site to release an adherent cuff. 5.9% with abnormal preprocedural bloodwork were noted to have some degree of bleeding at a pre-discharge review, however, no cases required further treatment, observation or intervention. Of the cases with normal preprocedural bloodwork, 93% were uneventful. 45 cases were noted to have documented evidence of bleeding upon review (6%). 2 were kept under extended observation without any further treatment necessary before being discharged. No intra-operative events were due to bleeding-related issues. When analysed using chi-square test, there is no statistical significance between pre-procedural bloodwork result and bleeding related complications (p-value 0.9397).

CONCLUSION

We have evaluated the use of blood testing before elective central venous device removal in a large cohort of patients at a tertiary referral center and shown that there is no significant benefit to the patient or to the performing service. This work will support the reduction in utilization of needless blood tests on pediatric patients, minimizing the stress and trauma these tests often cause our patients as well as reducing overall institutional cost and increasing efficiency.

METHODS

IRB approval was granted. Patients who underwent CVL removal (port-a-cath or central venous line) by Interventional Radiology between Jan 1st 2009 and Dec 31st 2013 were identified. Cases of device infection or malfunction were excluded. Patient records were reviewed and the data collected included patient demographics, underlying diagnosis, reason for device removal, history of bleeding disorder, device type, pre-and post-procedural bloodwork results, if any treatments were needed and what was given, as well as peri-operative bleeding complications (during or within 24hours of procedure). Data was collected by a single researcher and interval random data validity checks were performed. All data was recorded and analysed in Microsoft Excel.

PDF UPLOAD

https://abstract.rsna.org/uploads/2017/17018252/17018252_i6g4.pdf

SSE25-03 Predictors of Migration of Implantable Central Venous Port Devices

Monday, Nov. 27 3:20PM - 3:30PM Room: N226

Participants
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Jan Phillip Loschmann, Berlin, Germany (*Abstract Co-Author*) Nothing to Disclose
Bernd K. Hamm III, MD, Berlin, Germany (*Abstract Co-Author*) Research Consultant, Toshiba Medical Services Corporation ; Stockholder, Siemens AG; Stockholder, General Electric Company; Research Grant, Toshiba Medical Services Corporation Research Grant, Koninklijke Philips NV; Research Grant, Siemens AG ; Research Grant, General Electric Company; Research Grant, Elbit Imaging Ltd; Research Grant, Bayer AG ; Research Grant, Guerbet SA; Research Grant, Bracco Group; Research Grant, B. Braun Melsungen AG; Research Grant, KRAUTH medical KG ; Research Grant, Boston Scientific Corporation; Equipment support, Elbit Imaging Ltd; Investigator, CMC Contrast AB
Thomas Elgeti, MD, Berlin, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Catheter migration is one of the most common complications of central venous port devices. The aim of this study is identification of early risk factors for catheter migration which may be helpful in clinical maintenance of long term central venous ports.

METHOD AND MATERIALS

Retrospectively, 202 patients (98f; median age, 63 years; range, 19-83 years), with implanted central venous access port-systems via the right jugular vein placed in the interventional suite of the radiology department were included. Radio fluoroscopy (RF) was used for catheter placement, subsequently all patients underwent standard chest X-ray for assessment of port capsule migration. Location of catheter in RF was described using extra- (EX) and intravasal (IV) projection of catheter, ratio of EX/IV, length of catheter projection (CPL), normalized distance of the catheter tip from the carina (nCTCD) and projection of the port capsule relative to intercostal space (PCP). Associations of dislocation and possible risk factors (catheter characteristics as described above, age, gender, body weight, body height, BMI and thickness of presternal fat (PF) were analyzed using receiver operating characteristics (ROC) curves and logistic regression model.

RESULTS

Catheter migration was observed in 12 of 202 patients (5.9%). In univariate logistic regression catheter dislocation was significantly associated with body weight (OR, 1.04; p=0.009), BMI (OR, 1.15; p=0.002), presternal fat (OR, 1.15; p<0.001), EX (OR, 1.07; p=0.001), IV (OR, 1.03; p<0.001), EX/IV (OR, 1.10; p<0.001), CPL (OR, 1.02; p=0.001) and nCTCD (OR, 1.03; p<0.001) but not with age, gender, body height and PCP. The highest AUC in ROC analysis of females was observed for BMI (AUC, 0.91; p=0.006), EX/IV ratio (AUC, 0.88; p<0.001) and PF (AUC, 0.86; p=0.014). ROC analysis of males revealed the highest AUC for length of catheter (AUC, 1; p<0.001) and presternal fat (AUC, 0.85; p=0.004).

CONCLUSION

This explorative analysis identified length of catheter projection, BMI, thickness of presternal fat and ratio of extravasal/intravasal projecting catheter at time of radio fluoroscopy as significant risk factors for catheter dislocation.

CLINICAL RELEVANCE/APPLICATION

Length of catheter projection as well as ratio of extravasal/intravasal projecting catheter at time of radio fluoroscopy, body mass index and thickness of presternal fat in the lateral chest radiograph are risk factors for port catheter dislocation.

SSE25-04 Tunneled Central Venous and Dialysis Catheters in ICU Patients: Evaluation of CLABSI Rates

Monday, Nov. 27 3:30PM - 3:40PM Room: N226

Participants
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PURPOSE

Tunneled catheter placement in ICU patients is often deferred due to infection concerns despite lower infection rates than non-tunneled lines. The purpose of this study is to compare the incidence of Central Line Associated Bloodstream Infections (CLABSI) with tunneled central venous and dialysis catheters placed by Interventional Radiology in MICU or SICU patients versus historical overall CLABSI rates in the ICU setting.

METHOD AND MATERIALS

A retrospective single institution evaluation was performed. The database of procedural dictations was queried for reports with procedure codes for tunneled central venous and dialysis catheter placement originating from the MICU or SICU over a 12 month period. Reports were reviewed to ensure a tunneled central catheter was placed. The EHR was reviewed and the CLABSI rates were calculated based upon NHSN criteria and compared to publically available CLABSI rates for this institution. Patients still hospitalized with catheters were credited for catheter days until the day of final data analysis. Rates of line replacement and/or removal for reasons other than CLABSI were also evaluated.

RESULTS

A total of 981 catheter placements were performed with 53 in ICU patients. 25 were tunneled catheters, 13 in MICU and 10 in SICU patients (2 patients received both tunneled central venous and dialysis catheters). 23 internal jugular and 2 femoral catheters were placed. There were a total of 709 central line days, with 1 CLABSI in a SICU patient with a femoral tunneled line for TPN. CLABSI rate was 1.41 per 1000 catheter days. Publically available CLABSI rates for the MICU from 2013-2010 were 1.23, 1.54, 2.23, 1.59, respectively, and 0.27 in the SICU in 2013. 6 catheters were removed prior to discharge for reasons other than lack of need: 2 for malfunction, 2 for non-CLABSI infection, 1 for non-TPN use of TPN catheter in a code, and 1 for CLABSI.

CONCLUSION

The CLABSI rate of tunneled catheters in the ICU is comparable to overall ICU CLABSI rates from prior years. Additionally, 24% of catheters needed to be removed or replaced for other reasons requiring transport and IR sedation.

CLINICAL RELEVANCE/APPLICATION

The policy of deferring tunneled line placement in ICU patients is not justified based upon infection risk; however, it is warranted based upon rate of repeat procedures needed to replace/remove catheters. Patient specific considerations should guide the decision.

SSE25-05 An Analysis of Potential Predictors of Tunneled Central Venous Catheter Infection or Malfunction

Monday, Nov. 27 3:40PM - 3:50PM Room: N226

Participants
Andrew J. Gunn, MD, Birmingham, AL (*Abstract Co-Author*) Nothing to Disclose
Jae Sung, MD, Birmingham, AL (*Abstract Co-Author*) Nothing to Disclose
Jeffrey R. Black, BS, Birmingham, AL (*Presenter*) Nothing to Disclose
Eric Ursic, MD, Scottsdale, AZ (*Abstract Co-Author*) Nothing to Disclose
Sherif M. Moawad, MD,MSc, Birmingham, AL (*Abstract Co-Author*) Nothing to Disclose
Joseph B. Eason, MD, Richmond, VA (*Abstract Co-Author*) Nothing to Disclose
Ahmed K. Abdel Aal, MD, PhD, Birmingham, AL (*Abstract Co-Author*) Consultant, St. Jude Medical, Inc; Consultant, Baxter International Inc; Consultant, C. R. Bard, Inc; Consultant, Boston Scientific Corporation; Consultant, W. L. Gore & Associates, Inc;

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PURPOSE

To assess the ability of various clinical factors to predict infection or malfunction of tunneled central venous catheters (tCVCs).

METHOD AND MATERIALS

A retrospective review of all adult patients who had a tCVC placed by interventional radiology between 1/1/2012 and 12/31/2015

was performed. From this cohort, patients with a known indication for tCVC removal were included, while patients with femoral, trans-hepatic, or trans-lumbar tCVCs were excluded. tCVCs were considered infected based on clinical suspicion or culture-positive bacteremia. Malfunction was defined as all other non-infectious causes for line failure. Time to removal or exchange was recorded. Data was analyzed with univariate and multivariate models to assess for potential predictors of tCVC infection or malfunction, such as: age, sex, indication for tCVC placement, site of tCVC placement, inpatient versus outpatient status at time of placement, body mass index (BMI), platelet count, white blood cell count (WBC), international normalized ratio, and partial thromboplastin time. Positive blood cultures, sepsis, or fever within 30 days of placement were also analyzed as potential predictors.

RESULTS

441 patients (229F; 212M; mean age: 52.1 years) qualified for inclusion. The most common reasons for tCVC placement included: dialysis (175), long-term antibiotics (111), and malignancy (92). 98.4% were placed via the internal jugular vein. One minor complication occurred during tCVC placement. 13.8% of tCVCs were removed due to infection at a mean of 88.8 days (range: 0-217 days). 17.5% of catheters were removed or exchanged due to malfunction at a mean of 94.9 days (range: 1-684 days). The remainder of the tCVCs were removed due to completion of therapy at a mean of 89.9 days (range: 1-797). No differences in time to removal or exchange of tCVCs was seen between the groups. Leukopenia (WBC <4.5x103/mm3) was associated with tCVC removal for infection (p=0.03). Both female sex (p=0.02) and BMI >30 (p=0.04) were associated with tCVC removal or exchange for malfunction. None of the other evaluated factors were predictive of line removal or exchange.

CONCLUSION

Leukopenia was associated with tCVC removal for infection while female sex and BMI >30 were associated with tCVC malfunction. The other evaluated factors were largely poor predictors of tCVC removal or exchange.

CLINICAL RELEVANCE/APPLICATION

Improved models for patient selection prior to tCVC placement are needed.

SSE25-06 3D Bioprinted Veins-on-a-Chip Model

Monday, Nov. 27 3:50PM - 4:00PM Room: N226

Participants
Rahmi Oklu, MD, PhD, Scottsdale, AZ (*Abstract Co-Author*) Nothing to Disclose
Shrike Y. Zhang, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Hassan Albadawi, MD, Phoenix, AZ (*Presenter*) Nothing to Disclose
Ali Khademhosseini, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

In this study, 3D bioprinting technology was used for the construction of a highly biomimetic venous thrombosis-on-a-chip model.

METHOD AND MATERIALS

Thrombosis-on-a-chip model consisted of microchannels coated with a layer of confluent human endothelium embedded in a gelatin methacryloyl (GelMA) hydrogel, where human whole blood was infused and induced to form thrombi. Three groups of hydrogel micro channels were fabricated using sacrificial bioprinting approach: i) microchannels covered by HUVECs without fibroblasts (control), ii) non-endothelialized microchannels with encapsulated fibroblasts in the hydrogel, and iii) endothelialized microchannels with simultaneously encapsulated fibroblasts inside the matrix. Mechanical tests, cell viability, morphology analysis, perfusion assays with and without tPA treatment, immunohistochemistry (CD-31, f-actin, collagen-1) and histology were performed; changes over 14 days was documented using video fluorescent microscopy.

RESULTS

A biomimetic thrombosis-on-a-chip model was successfully created. Encapsulation with fibroblasts in the GelMA matrix demonstrated the migration of these cells into the clot and subsequent deposition of collagen type I over time, facilitating fibrosis remodeling resembling human thrombus organization. Continuous perfusion with tPA led to dissolution of non-fibrotic clots, further revealing clinical relevance of the model.

CONCLUSION

3D bioprinted models can be used to study the pathology of venous fibrosis and test therapeutics.

CLINICAL RELEVANCE/APPLICATION

Biomimetic human tissue on a chip models can lead to rapid in vitro testing of therapeutics and medical devices.

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MSRO36

BOOST: Lung-Science Session with Keynote

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S103CD

CH RO OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Meng X. Welliver, MD, Columbus, OH (*Moderator*) Nothing to Disclose
Matthew M. Harkenrider, MD, Maywood, IL (*Moderator*) Nothing to Disclose

Sub-Events

MSRO36-01 Invited Speaker:

Tuesday, Nov. 28 10:30AM - 10:50AM Room: S103CD

Participants
Matthew M. Harkenrider, MD, Maywood, IL (*Presenter*) Nothing to Disclose

MSRO36-03 Therapeutic Response Prediction in Non-Small Cell Lung Cancer After Conservative Therapy: Utility of Multiparametric Approach by Quantitatively Assessed Dynamic First-Pass Contrast-Enhanced Perfusion MRI with FDG-PET/CT

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S103CD

Participants
Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Presenter*) Research Grant, Toshiba Medical Systems Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Fuji Pharma Co, Ltd; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Guerbet SA;
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PURPOSE

To directly compare the capability for therapeutic response prediction by among quantitatively assessed dynamic CE-perfusion MRI, FDG-PET/CT and multiparametric approach by both modalities in non-small cell lung cancer (NSCLC) patients treated with chemoradiotherapy.

METHOD AND MATERIALS

43 consecutive Stage IIIB NSCLC patients (25 men, 18 women; mean age 67 year old) underwent PET/CT, dynamic CE-perfusion MRI, chemoradiotherapy, and follow-up examination. In each patient, therapeutic outcomes were assessed as therapeutic effect based on RECIST guideline. Then, all patients were divided into two groups as follows: 1) responders (CR+PR cases: n=23) and 2) non-responders (SD+PD cases: n=20). In each patient, total perfusion (TP) and tumor perfusions from pulmonary (TPP) and systemic (TPS) circulations calculated from dynamic CE-perfusion MR data and SUVmax on PET/CT were assessed at each targeted lesion, and averaged to determine final values. To determine each index difference between two groups, Student's t-test was performed. Then, multivariate logistic regression analysis was performed to investigate the discriminating factors of responders. In addition, ROC analysis was performed to compare diagnostic performance between multiparametric approach and each radiological index. Finally, sensitivity, specificity and accuracy were compared among all methods by McNemar's test.

RESULTS

All indexes had significant differences between responder and non-responders ($p<0.05$). Multivariate regression analysis identified SUVmax (Odds ratio [OR]: 2.56) and TP (OR: 0.68) as significant differentiator of responder. ROC analysis showed area under the curve (Az)of multiparametric approach (Az=0.95) was significantly larger than that of TPP (Az=0.72, p=0.001). Sensitivity (95.7 [22/23] %) of multiparametric approach was significantly higher than that of TP (69.6 [16/23] %, p=0.03) and TPP (65.2 [15/23] %, p=0.02).

CONCLUSION

Multiparametric approach by dynamic CE-perfusion MRI and PET/CT can improve the capability for therapeutic response prediction as compared with each modality alone in NSCLC patients after conservative therapy.

CLINICAL RELEVANCE/APPLICATION

Multiparametric approach by dynamic CE-perfusion MRI and PET/CT can improve the capability for therapeutic response prediction as compared with each modality alone in NSCLC patients after conservative therapy.

MSRO36-04 Current Treatment Practices for Limited-Stage Small Cell Lung Cancer: A Survey of US Radiation Oncologists on Their Use of Prophylactic Cranial Irradiation

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S103CD

Participants
Matthew J. Farrell, Portland, OR (*Presenter*) Nothing to Disclose
Jehan Yahya, Portland, OR (*Abstract Co-Author*) Nothing to Disclose
Catherine Degnin, PhD, MPH, Portland, OR (*Abstract Co-Author*) Nothing to Disclose
Yiyi Chen, Portland, OR (*Abstract Co-Author*) Nothing to Disclose
John M. Holland, MD, Clackamas, OR (*Abstract Co-Author*) Nothing to Disclose
Mark A. Henderson, MD, Indianapolis, IN (*Abstract Co-Author*) Nothing to Disclose
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METHOD AND MATERIALS

We surveyed practicing US radiation oncologists via an online questionnaire. Questions covered background characteristics, self-rated knowledge of several key trials, and treatment recommendations for LS-SCLC.

RESULTS

We received 309 complete responses from practicing radiation oncologists. 98% recommend PCI for patients with LS-SCLC, 96% obtain a brain MRI prior to PCI, 33% routinely obtain serial brain imaging with MRI to detect new metastases, and 35% recommend memantine for patients undergoing PCI. Recommending memantine was associated with fewer years post residency training (p=0.0003), fewer lung cancer patients treated per year (p=0.045), and fewer LS-SCLC patients treated per year (p=0.024).

CONCLUSION

Practice patterns among US radiation oncologists strongly align with NCCN guidelines, which recommend brain MRI and PCI for patients with LS-SCLC who show a good response to initial therapy. These practices are not directly supported by the clinical trials that shaped them, as the trials used either CT scans of the brain or no brain imaging prior to PCI. Recent Japanese studies in patients with extensive-stage and limited-stage SCLC suggest that the benefits of PCI might disappear when brain MRI is incorporated. A third of respondents prescribe memantine to patients undergoing PCI; while no trials have studied memantine in the context of PCI for LS-SCLC patients, a phase III trial did show memantine delayed cognitive decline in patients treated with whole brain radiotherapy for brain metastases. Further research and a reevaluation of guidelines are warranted to determine the best treatment for patients with LS-SCLC.

CLINICAL RELEVANCE/APPLICATION

Our survey of practicing US radiation oncologists shows strong adherence to NCCN guidelines for the use of PCI in LS-SCLC, and it establishes a practice pattern baseline for future clinical trials.

MSRO36-05 Thoracic Radiation Therapy Significantly Improve the Survival of Extensive Stage Small Cell Lung Cancer after Chemotherapy

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S103CD

Participants
Lei Deng, Oak Brook, IL (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Our study is aimed to evaluate the influence of Thoracic Radiation Therapy (TRT) on survival in extensive stage small cell lung cancer(SCLC) after chemotherapy.Materials/Methods: A retrospective review was conducted on extensive stage SCLC patients received chemotherapy±TRT from January 2007 to December 2012. Most patients received initial chemotherapy with carboplatin plus etoposide or chemotherapy with cisplatin plus etoposide. TRT was performed through three dimensional conformal Radiation Therapy (3D-CRT) or intensive modified radiotherapy(IMRT). The median thoracic radiation dose was 56 Gy (32~67 Gy) with 1.8~2.3 Gy per fractions. The effect of TRT on overall survival (OS) and progress free survival (PFS) was evaluated with Kaplan-Meier method and log-rank test. Statistically significant difference was set as pResults: Overall, 353 consecutive patients were enrolled. Follow-up rate was 95.5%. Patients reaching CR (complete response), PR (partial response), SD (stable disease), PD (progressive disease) after chemotherapy accounted for 2.3%, 62.6%, 21.8%, and 13.3% respectively. 130 cases of patients (36.8%) had conducted TRT. The characteristics were comparable between the TRT and non-TRT groups except that the patients conducting prophylactic cranial irradiation (PCI) were more prevalent in the TRT group. The median follow-up time for survival patients was 58.6 months. The median overall survival (OS) of the whole group was 13.3±0.5 months (95% CI: 12.3-14.3) and the median progression-free survival (PFS) was 9.0±0.3 months (95% CI: 8.3-9.7). TRT significantly improved the OS and PFS. The median OS was 20.0±1.3 months in TRT group, while 10.6±0.5 months in non-TRT group; the median PFS were 11.0±0.7 months and 7.2±0.3 months respectively in the two groups (pConclusion: For all extensive stage SCLC patients with different brain metastasis status and response after chemotherapy, TRT can significantly improve OS and PFS and decrease the loco-regional recurrence rate.

MSRO36-06 A Pilot Study Comparing the Value of 18F-Alfatide PET/CT and 18F-FDG PET/CT in Predicting Chemoradiotherapy Sensitivity in Patients with Advanced Non-Small Cell Lung Cancer

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S103CD

Participants
Shuanghu Yuan, PhD, Jinan, China (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Both 18F-alfatide positron emission tomography/computed tomography(PET/CT) and 18F-fluorodeoxyglucose (18F-FDG) PET/CT were potential in predicting thearapy sensitivity, in this study, we recruited patients with advanced NSCLC to detect and compare the potential predictive vaue of them on the CRT sensitivity of patients with advanced non-small cell lung cancer (NSCLC).Materials/Methods: According to the design of Natural Science Foundation of China (NSFC) 81372413, twenty-four patients with advanced NSCLC accepted 18F-alfatide PET/CT before radiotherapy (T1), another thirty-nine patients underwent 18F-FDG PET/CT at both T1 and during CRT (40Gy of radiotherapy, T2). Logistic regression analysis was used to evaluate the correlations between PET parameters and CRT sensitivity providing an odds ratio (OR), 95% confidence interval (CI) and p value. Propensity score matching (PSM) approach was used to control confounding.Results: Logistic regression analyses showed that Karnofsky Performance Status (KPS) score was correlative with CRT sensitivity. After PSM, controlling KPS scores, twenty-four pairs of patients were matched. The results showed that SUVmax obtained from baseline 18F-alfatide PET/CT was associated with CRT sensitivity in both univariate and multivariable logistic regression analysis (OR: 0.532, 95% CI: 0.305–0.927, p=0.026; OR:0.376, 95% CI: 0.165-0.860, p= 0.021), but the baseline 18F-FDG PET/CT was not. Univariate analysis showed that the percent change in MTV of 18F-FDG PET/CT between T1 and T2 was correlative with CRT sensitivity (OR: 1.039, 95% CI: 1.003-1.077, p=0.036). When patients' KPS score was considered simultaneously, it was still related to CRT sensitivity (OR:1.038, 95% CI: 1.001-1.077, p=0.045).Conclusion: 18F-alfatide PET/CT may be better than 18F-FDG PET/CT in predicting CRT sensitivity, and 18F-FDG PET/CT is potential in monitoring the tumor response to CRT in patients with advanced NSCLC.

MSRO36-07 Tumor Ablation versus Stereotactic Body Radiation Therapy (SBRT) for Treatment of Stage 1 Non-Small Cell Lung Cancer: A Propensity Score Matching Analysis

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S103CD

Awards
Student Travel Stipend Award

Participants
Jing Wang, BA , Providence, RI (*Presenter*) Nothing to Disclose
Aaron W. Maxwell, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Elaine M. Tran, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Richard N. Jones, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Jaroslaw Hepel, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Thomas A. Dipetrillo, MD, Providence, RI (*Abstract Co-Author*) Research Consultant, Source Product Engineering Co Research Consultant, Accelerated Technologies
Damian E. Dupuy, MD, Providence, RI (*Abstract Co-Author*) Research Grant, NeuWave Medical Inc Board of Directors, BSD Medical Corporation Stockholder, BSD Medical Corporation Speaker, Educational Symposia

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PURPOSE

To compare patient- and treatment-level outcomes among patients with stage 1 non-small cell lung cancer treated with thermal ablation or stereotactic body radiation therapy (SBRT).

METHOD AND MATERIALS

This HIPAA-compliant study was performed following institutional review board approval with a waiver for informed consent. A retrospective review of the electronic medical record at our institution was performed to identify patients with biopsy-proven stage I non-small cell lung cancer who underwent treatment with thermal ablation or SBRT. A one-to-one propensity score-matched analysis was performed to identify intermodality differences in rates of overall disease progression, local tumor recurrence, and new metastatic disease. Overall survival was also compared between groups. Patient age, sex, tumor size, tumor stage, smoking history, and Charlson Comorbidity Index were used as matching variables. Statistical significance was set a priori at $a<0.05$.

RESULTS

A total of 249 patients met inclusion criteria, with 150 treated with thermal ablation and 99 treated with SBRT. 84 patients in each group were deemed satisfactory for matching. In the unmatched dataset, ablation patients were significantly older (75.33 years old vs 63.53 years, p<.001) and more likely to be current tobacco users. (23.3% vs 12.1%, p=0.027). Following propensity score matching, these differences became nonsignificant; all other matching factors were insignificant pre- and post-matching. Ablation and SBRT showed no significant difference in overall disease progression (47.6% for ablation vs 39.3% for SBRT, p=0.276). Ablation patients had a significantly higher local tumor recurrence rate (45.2% vs 20.2%, p=.001) but had a lower metastasis rate (2.4% vs 19.0%, p<.001). Overall mortality rates were comparable (15.5% for ablation vs 11.9% for SBRT, p=.501).

CONCLUSION

Among patients with stage I non-small cell lung cancer, thermal ablation and SBRT showed comparable rates of disease progression and overall survival using a propensity score-matched analysis. Observed local tumor recurrence rates were higher with ablation, while new metastatic disease occurred more frequently with SBRT.

CLINICAL RELEVANCE/APPLICATION

Thermal ablation yields comparable long-term clinical outcomes to stereotactic body radiation therapy among patients with stage I non-small cell lung cancer.

MSRO36-08 Participants

Role of Postoperative Radiotherapy (PORT) in Stage pN2 Non-Small-Cell Lung Cancer(NSCLC) Receiving Pneumonectomy

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S103CD

Wenhui Wang, Zhengzhou, China (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): For patients with resected stage pN2 NSCLC, adjuvant chemotherapy followed by PORT is the standard treatment option. However, for those who received pneumonectomy, the use of PORT has no definitive evidence about its effectiveness. This study is to evaluate the effect of PORT on survival and explore the role of PORT for such population.Materials/Methods: Between Jan. 2003 and Mar. 2015, patients with stage pN2 NSCLC who underwent pneumonectomy were retrospectively reviewed. Those who received adjuvant chemotherapy with or without PORT were included in this study. Platinum-based doublet chemotherapy of 4 cycles was used. Radiotherapy was performed by 3D-CRT/ IMRT to the total dose of 50-60 Gy. The effect of PORT on survival was evaluated by Kaplan-Meier method and log-rank test. Pearson chi-Square test was used to compare the constituent ratios between groups. Statistically significant difference was set as pResults: Among 108 patients with stage pN2 NSCLC who underwent pneumonectomy, 64 patients received adjuvant therapy, including 14 patients receiving sequential adjuvant chemotherapy and PORT, and 50 patients receiving chemotherapy alone. The characteristics of patients between the two groups were comparable (p>0.05), which included gender, age, KPS, tumor site, preoperative lung function and pathological type, and et al. Of all the 64 patients, the median follow-up time was 25.5months. The 1-, 3- and 5-year cancer specific survival (CSS) rates were 79.4%,47.2% and 37%, respectively. The 1-, 3- and 5-year CSS rates were------ in the PORT group, which were significantly better than those of ------in the control group (p=0.041). The median CSS time has not reached yet in the PORT group and was 34 months in the control group. The overall survival (OS) and distant metastasis free survival (DMFS) trended to be significantly increased in the PORT group than those in the control group (p=0.084 and p=0.074, respectively). However, the local recurrence free survival (LRFS) between the two groups was not statistically different (p=0.481). Grade 3 or more radiation induced acute or chronic pneumonitis and esophagitis were not observed. There was no radiation toxicity related death.Conclusion: For patients with stage pN2 NSCLC after pneumonectomy and adjuvant chemotherapy, PORT may be considered as the treatment option, since it is safe and can improve the CSS, and trends to improve the OS and DMFS. Further verification of our result is needed in the future study.

MSRO36-09 Dosimetric Comparison on the Accuracy of Dose Calculation Algorithms Measured in Inhomogeneous Phantom in the Case of Lung SBRT

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S103CD

Participants
Sarahatul Bahiah Yusoff, Singapore, Singapore (*Presenter*) Nothing to Disclose

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ABSTRACT

Purpose/Objective(s): Substantial dose inaccuracies can be shown in inhomogeneous regions due to loss of electronic equilibrium from loss of tissue or dose degradation at tissue interfaces. Lung SBRT typically is high dose in nature and therefore requires a sharp dose fall-off from the planning target volume (PTV) to the organs at risk (OAR). This study aims to evaluate the dosimetric comparison between dose distributions calculated with Acuros XB (AXB) grid-based Linear Boltzmann Transport Equation (LBTE) algorithm and X-ray Voxel Monte Carlo (XVMC) model based algorithm for patients undergoing lung SBRT.Materials/Methods: 12 Intensity Modulated Radiation Therapy (IMRT) and 12 Volumetric Modulated Arc Therapy (VMAT) treatment plans were created on the 0.1 cm CT study set slices of the inhomogeneous phantom targeting a 13.7cm3 PTV within the 598.1cm3 cedar insert (lung), 45 Gy at 9Gy/fraction was prescribed with 5 coplanar 6MV IMRT beams or 2 dynamic conformal arcs. Treatment planning variations included having more and different constraints onto the mock OARs. Plans were first optimized and calculated with AXB and then recalculated with XVMC utilising 0.3cm3 grid size. Dosimetric comparison for the 2 algorithms were performed and evaluated using independent software in terms of dose volume histogram(DVH) statistics related to PTV coverage and OARs doses, homogeneity (HI) and conformity (CI) indices. Dosimetric validation was performed with ion chamber measurements.Results: DVH results showed positive gains for IMRT calculated plans as compared to VMAT. AXB IMRT calculated plans yielded a minimum 95.0% coverage and global maximum of 113.0% for PTV; mean and maximum doses for lung at 20.8% and 114.0%; HI and CI at 0.123 and 1.017. XVMC IMRT calculated treatment plans yielded a minimum 94.8% coverage and global maximum of 125.8% for PTV, mean and maximum doses for lung at 20.2% and 128.5%; HI and CI of 0.245 and 1.022. Dosimetric validation showed that both algorithms agreed with measurements to within 3%.Conclusion: Both AXB and XVMC calculated treatment plans were able to meet our departmental requirements for treating lung SBRT cases. However, our experience found that AXB IMRT calculated plans showed optimal plans with better PTV coverage with lesser dose gradients, lowest lung dose as well as better Hi and CI. This study confirms that AXB algorithm adequately accounts for doses within tissue inhomogeneities.

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SSG01

Breast Imaging (Ultrasound Diagnostics)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: E451A

BR US

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Donna M. Plecha, MD, Strongsville, OH (*Moderator*) Research Grant, Hologic, Inc;
Susan Weinstein, MD, Philadelphia, PA (*Moderator*) Consultant, iCAD, Inc

Sub-Events

SSG01-01 A Multi-center Study of ABUS for the Diagnosis of Breast Cancer in China

Tuesday, Nov. 28 10:30AM - 10:40AM Room: E451A

Participants
Xi Lin, Guangzhou, China (*Presenter*) Nothing to Disclose
Ling-Yun Bao, Hangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Xiang Zhou, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Yaqing Chen, PhD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Peifang Liu, MD, PhD, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose
You-Lin Qiao, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Anhua Li, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Mammography (MAM) is the first choice of breast screening. However, its practicability is limited in Asian due to dense breast. Meanwhile, hand held ultrasound (HHUS) has obvious operator dependece and poor repeatability. Automated Breast Ultrasound System (ABUS) is a potential method to alleviate current challenges. This study aims to evaluate the initial effectiveness of ABUS by comparing it with Hand Held Ultrasound (HHUS) and Mammography (MAM) in a hospital-based multi-center study.

METHOD AND MATERIALS

Women between the ages of 30 to 69 who visited breast surgeons for the first time without visible, suspicious signs of breast cancer were eligible for our study. All participants underwent HHUS and ABUS, and women in the older group (40 to 69 years old) also received MAM. Image interpretations were done without knowledge of clinical or other imaging results. Lesions classified as BI-RADS 4 or 5 were considered to be "suspicious", and BI-RADS 1 to 3 lesions were assessed as "benign". So far, 1010 eligible women had been enrolled and 656 in the older group. Taking breast as the unit of analysis, we had acquired 2020 HHUS results, 2020 ABUS results and 1312MAM results. The consistency rates and Kappa statistics were calculated to assess the reliability of ABUS compared with HHUS or MAM.

RESULTS

The average subject age was 45.32 (SD 9.756) in the whole group and 50.82 (SD 7.489) in the older group. Of all the 2020 breasts, HHUS detected 395 suspicious lesions and ABUS detected 356 suspicious lesions. Among the 395 suspicious lesions detected by HHUS, ABUS detected 327; In the older group, ABUS detected 275 suspicious lesions and MAM detected 259 suspicious lesions. Among the 259 suspicious lesions detected by MAM, only 41 lesions were undetected by ABUS. Among the 275 lesions detected by ABUS, only 57 were not detected by MAM. Specifically, the consistency rate between HHUS and ABUS was 95.2%, and that between ABUS and MAM was 92.53%. The Kappa value between ABUS and HHUS was 0.8414 and that of ABUS and MAM in the older group was 0.7696.

CONCLUSION

Fairly good reliability was observed in comparisons between ABUS and HHUS or MAM in our initial analysis. It is feasible for all the radiologists with a short term of training of ABUS to have similar lesion interpretation as HHUS or MAM by specialists. ABUS is a promising modality in breast imaging.

CLINICAL RELEVANCE/APPLICATION

ABUS is a promising modality in breast imaging.

SSG01-02 Tumor Doubling Time of Breast Cancer Measured By Ultrasonography: Correlation with Tumor Subtype, Ki-67 Value and Nuclear Grade

Tuesday, Nov. 28 10:40AM - 10:50AM Room: E451A

Participants
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PURPOSE

To evaluate tumor doubling time (DT) of breast cancers using ultrasonography and compare DT with tumor subtypes and histopathological findings.

METHOD AND MATERIALS

We included 262 patients with invasive breast carcinomas who received serial ultrasonography (US) at least twice during preoperative period from April 2014 to September 2016. The mean interval between initial and second US was 56.5 days (range, 12-119). Ultrasound examinations were performed by four experienced ultrasonographers. Tumor diameters were measured in three directions and tumor volumes were approximated by ellipsoids. The DT was calculated according to the Collins method from the interval between US examinations and the change in tumor volume. We also compared DT with tumor subtypes, Ki-67 values and nuclear grades. Tumor subtypes were defined as luminal (ER+/HER2-), luminal-HER2 (ER+/HER2+), HER2 (ER-/HER2+), and triple negative (ER-/HER2-).

RESULTS

The mean tumor volume at initial and second US were 2994 mm3 and 3299 mm3, respectively. The observed volume did not change in 94 of 262 (36%) tumors between initial and second US and increased in 124 of 207 (60%) luminal, 12 of 15 (80%) luminal-HER2, 9 of 13 (69%) HER2, and 23 of 27 (85%) triple-negative tumors. Triple-negative tumors showed volume increase more frequently than luminal tumors ($p = 0.011$). Mean DT of luminal tumors was longer than that of triple-negative tumors (190 and 128 days, respectively; $p = 0.042$). Volume-increased tumors had significantly higher Ki-67 values than those of volume-stable tumors (all subtypes, 31 vs 18; $p < 0.001$, luminal, 24 vs 17; $p = 0.002$) and higher nuclear grades (all subtypes, 1.77 vs 1.41; $p = 0.001$, luminal, 1.50 vs 1.29; $p = 0.022$). In triple-negative tumors, Ki-67 values of short DT (< 90 days) tumors were significantly higher than those of long DT (> 90 days) tumors (mean, 83 and 41, respectively; $p = 0.005$).

CONCLUSION

The difference of tumor growth rate depending on breast cancer subtype, Ki-67 value and nuclear grade was confirmed by measuring DT using ultrasonography.

CLINICAL RELEVANCE/APPLICATION

Considering breast cancer subtypes and other pathological factors are helpful in predicting tumor growth rate and planning surgical waiting time or neoadjuvant chemotherapy.

SSG01-03 The Importance of Peritumoral Comparisons by Ultrasound Tomography: Radiomics and Breast Mass Discrimination

Tuesday, Nov. 28 10:50AM - 11:00AM Room: E451A

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PURPOSE

Ultrasound tomography (UST) provides quantitative whole breast imaging that may improve the specificity of breast cancer screening and diagnoses by combining reflection (REF), attenuation (ATT) and speed of sound (SS) imaging. We assessed whether multiple image analyses of radiomics could improve discrimination of benign from malignant masses.

METHOD AND MATERIALS

This HIPAA compliant, IRB approved trial accrued 115 patients with 161 breast masses. Sequential coronal REF images and quantitative transmission imaging of SS (m/sec) and ATT (dB/cm/MHz) were generated at 2mm spacing. For each mass, an experienced breast radiologist characterized tumor-peritumoral regions on a 5-point BIRADS-like margin boundary (MB) score ranging from well circumscribed to highly spiculated. Masses were outlined by a hand-drawn vs. simple ellipse ROI that generated an intra-tumoral (iT) and an outer radial peri-tumoral (pT) ROI (see Figure). Extensive radiomics parameters were analyzed to address quantitative and textural differences between benign and malignant masses and their iT:pT comparisons. Supervised learning techniques were applied to generate classifier models.

RESULTS

68 cancers, 55 fibroadenomas and 38 cysts were analyzed. Cancers had more irregular margins (N=47/68 with MB>=4) than cysts or fibroadenomas (0 total with MB>=4)(p<0.0001). Using only the radiologist's MB score with a cut-point of MB >= 3, a sensitivity (SEN) of 82%, specificity (SPE) of 91%, and a positive predictive value (PPV) of 88% was noted. 520 radiomic features were reduced to 47 with the greatest information gain, of which more pT than iT metrics were preserved. Morphological metrics from the hand-drawn contour gave similar results to the MB. Combing radiomics from the elliptical ROI and MB data using a support vector machine classifier gave SEN=82%, SPE=95%, and PPV=97%.

CONCLUSION

Radiomics and supervised learning techniques can improve radiologists' discrimination of breast masses by quantifying iT and pT textural detail to potentially improve biopsy PPV for an ongoing UST screening trial .

CLINICAL RELEVANCE/APPLICATION

A rapidly implemented ROI tool during future breast cancer screening by whole breast UST can gather sufficient radiomics data to support reductions in call-backs and biopsies. UST radiomics requires validation by a large number of breast masses.

SSG01-04 Associations Between the Ultrasound Features of Invasive Breast Cancer and Breast Cancer Specific Survival

Tuesday, Nov. 28 11:00AM - 11:10AM Room: E451A

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PURPOSE

Pre-operative prognostic information is useful when treating women with breast cancer especially with regard to assessing the appropriateness of neoadjuvant chemotherapy. The aim of this study is to identify associations between the ultrasound (US) features of invasive breast cancer and breast cancer specific survival (BCSS).

METHOD AND MATERIALS

287 consecutive women within a single breast service (mean age 63 yrs) with US visible invasive breast cancers were documented prospectively between January 2010 and December 2012. The US features of the lesions were evaluated retrospectively from the recorded images according to the BI-RADS US lexicon by a breast radiologist blinded to outcomes. Survival, including cause of death, was ascertained from local and national sources. Kaplan-Meier survival curves were generated and statistical significance ascertained using the Log-Rank test.

RESULTS

Twenty seven breast cancer deaths and 31 non-breast cancer deaths occurred in the sample. Mean follow-up in those alive is 5.5 years. Distal acoustic enhancement was associated with a 72% 5 year BCSS compared to 93% and 97% for those with distal shadowing or no distal effect (p<0.0001). Skin involvement (either direct invasion or skin thickening over the mass) was associated with 78% 5 year BCSS compared to 94% in women without skin involvement (p=0.0001). Women in the highest tertile of US lesion diameter had a 5 year BCSS of 83% compared to 96% for women in the middle and smallest tertiles (p=0.0004). Mass shape, echogenicity and margin characteristics, orientation or BIRADS score were not associated with BCSS.

CONCLUSION

The presence of distal acoustic enhancement and skin involvement at US have strong associations with breast cancer death and these factors should be taken into account along with lesion size and other conventional prognostic features when considering management of women with invasive breast cancer. Our study is limited by a small sample size and relatively short follow-up. Further studies evaluating larger number of patients to assess patient outcomes will be of value.

CLINICAL RELEVANCE/APPLICATION

Distal acoustic enhancement and skin involvement at US seem to be poor prognostic factors strongly associated with breast cancer death, meriting consideration in initial management of breast cancer.

SSG01-05 Optoacoustic Imaging Detects Changes in Breast Parenchyma in Relation to Hormonal Status of Healthy Female Volunteers: An Important Step in Clinical-Translation

Tuesday, Nov. 28 11:10AM - 11:20AM Room: E451A

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PURPOSE

Optoacoustic imaging (OPUS) is an emerging clinical imaging modality that allows the assessment of tissue oxygenation through surrogate measures of oxy/deoxy and total hemoglobin. One of the first steps in establishing the clinical utility of an imaging technique is to evaluate its technical ability to depict the appearances of normal tissue and the impact of normal physiology on the imaging readout. The aim of our study was to evaluate the ability of OPUS to detect tissue oxygenation and vascularity changes in relation to hormonal status.

METHOD AND MATERIALS

Following IRB approval this prospective study was performed between January and July 2016. 22 pre-menopausal and 8 post-menopausal volunteers were recruited. Pre-menopausal volunteers were scanned using OPUS (700, 800 and 850 nm wavelengths) in the proliferative/follicular (day 5-14) and secretory phases (day 21-28) of the menstrual cycle. Repeatability data was available in 16 volunteers. Regions of interest for quantitative analysis were drawn on the most superficial region of fibroglandular tissue as determined by ultrasound in the left breast. Statistical analysis of the mean signal intensity of the ROIs was performed in GraphPad Prism (annova, linear regression and t tests).

RESULTS

Optoacoustic intensity rose significantly at all wavelengths: the mean values at 700, 800 and 850nm rose from 14.45, 14.47, 13.14 in the proliferative phase to 18.37, 18.14, 17.18 in the secretory phase ($p<0.01$). Post-menopausal volunteers showed similar optoacoustic features and values to the proliferative/follicular phase. Our hand-held probe showed high test-retest correlation ($r = 0.72$-0.81).

CONCLUSION

OPUS shows comparable repeatability to other hand-held breast imaging modalities and sensitively detects the expected changes in breast parenchyma vascularity during the menstrual cycle in healthy volunteers.

CLINICAL RELEVANCE/APPLICATION

When developing a new technique to evaluate breast disease e.g. optoacoustic imaging, it is important to establish the base line variation of normal and use known physiological physiological changes and repeatability data to refine and validate quantification of image intensity.

SSG01-06 Shear Wave Velocity of the Lesion in Preoperative Breast Ultrasonography: Association with Disease-Free Survival of Patients with Primary Operable Invasive Breast Cancer

Tuesday, Nov. 28 11:20AM - 11:30AM Room: E451A

Participants
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PURPOSE

To investigate the relationship between shear wave velocity (SWV) of the lesion in preoperative breast ultrasonography (US) and disease-free survival in patients with primary operable invasive breast cancer.

METHOD AND MATERIALS

This retrospective study was approved by our institutional review board. The requirement for informed consent was waived. A total of 195 consecutive newly diagnosed invasive breast cancer patients (age 33-83 years; mean 54.0 years) who had undergone preoperative breast US with SWV measurement of the lesion and surgery between May 2012 and May 2013 were identified. SWV was measured at the center and three marginal zone in breast lesions using a 5 × 5 mm region of interest, and the maximum value was used. For 35 patients who underwent primary systemic therapy (PST), the maximum SWV before PST was used. Cox proportional hazards modeling was used to identify the relationship between clinical-pathologic factors and disease-free survival.

RESULTS

Fourteen recurrences occurred at 6-47 months (mean 22.3 months) after surgery. Larger lesion size (hazard ratio [HR] = 1.034; 95% confidence interval [CI]: 1.002, 1.066; P = 0.037), negative estrogen receptor status (HR = 0.335; 95% CI: 0.112, 0.999, P = 0.049), negative progesterone receptor status (HR = 0.274; 95% CI: 0.095, 0.789, P = 0.016), overexpression of human epidermal growth factor receptor-2 (HR = 4.109; 95% CI: 1.375, 12.282, P = 0.011), positive PST (HR = 6.754; 95% CI: 2.342, 19.481, P < 0.001), and higher maximum SWV (HR = 1.616; 95% CI: 1.113, 2.348, P = 0.012) were associated with poorer outcomes at univariate analysis. At multivariate analysis, positive PST (HR = 6.502; 95% CI: 2.248, 18.802, P = 0.001) and higher maximum SWV (HR = 1.583; 95% CI: 1.102, 2.275, P = 0.013) were associated with poorer disease-free survival.

CONCLUSION

Higher maximum SWV in preoperative US was significantly associated with poorer disease-free survival of patients with invasive breast cancer.

CLINICAL RELEVANCE/APPLICATION

SWV in preoperative US of primary operable invasive breast cancer could be useful for assessing disease-free survival after surgery

SWV in preoperative US of primary operable invasive breast cancer could be useful for assessing disease-free survival after surgery.

SSG01-07 Breast Ultrasound Utilization in the Emergency Setting: Can We Do Better?

Tuesday, Nov. 28 11:30AM - 11:40AM Room: E451A

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PURPOSE

To assess the clinical utility of breast ultrasound (US) performed in the emergency department (ED) for suspected breast abscess and to determine factors associated with confirmed abscess.

METHOD AND MATERIALS

Retrospective analysis of 581 consecutive breast US to evaluate for abscess in a large safety-net ED over a 15 month period was performed. Imaging results, demographics, laboratory data, and physical exam findings were reviewed. Breast abscess, defined by the presence of a fluid collection with clinical signs and symptoms of infection, was confirmed by a combination of US results, clinical findings, laboratory data, and when possible, the presence of purulent fluid.

RESULTS

Of the 581 US performed for suspected abscess, final diagnoses included: abscess (26%, n=150), malignancy (5%, n=27), granulomatous mastitis (5%, n=31), normal (21%, n=122) and other (including indeterminate, 43%, n=251). Clinical factors predictive of abscess on multivariable analysis included physical exam findings (induration, fluctuance, erythema, and drainage), smoking, and race. Based on these factors, the area under the curve (AUC) was 0.83 (CI 0.80-0.87) for the detection of abscess. The presence of temperature > 38 degrees Celsius and leukocytosis were not significant. Of 49 US performed for pain in the absence of additional physical exam findings, only 1 was positive for an abscess. Additional studies were recommended in 308 US, with 248 due to technical inadequacy or the need for mammographic evaluation. Six breast cancers were either not demonstrated or not diagnosed on US performed in the ED.

CONCLUSION

Breast US in the ED is overutilized and has limited clinical value given the low positivity rate, the need for repeat exams, and the risk of missed cancers. Use of both clinical findings and patient demographics can improve patient selection for and diagnostic utility of US to reduce unnecessary exams. Patients with a low likelihood of abscess should be imaged in a more optimal setting.

CLINICAL RELEVANCE/APPLICATION

This study will help clinicians better utilize emergent breast US services.

SSG01-08 Utility of Real-Time Breast Ultrasound Examination after Second Opinion Review of Submitted Studies in a Comprehensive Cancer Center

Tuesday, Nov. 28 11:40AM - 11:50AM Room: E451A

Participants
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PURPOSE

To determine if real-time diagnostic breast ultrasound evaluation after reinterpretation of submitted static ultrasound images at a comprehensive cancer center impacts clinical management, specifically by detecting additional cancer and preventing unnecessary biopsy.

METHOD AND MATERIALS

Retrospective HIPAA compliant IRB-approved review was performed of submitted breast ultrasound studies between January 2013 and May 2014 for 209 patients seeking second opinions for which real-time ultrasound re-evaluation (RTUR) at our institution was recommended to characterize lesions depicted on the submitted static images. Each case was evaluated for concordance between the original report and diagnostic RTUR. Second-opinion review and subsequent RTUR resulting in recommendation and performance of new biopsies was subdivided into benign, high-risk, and malignant based on histopathology obtained at our institution. Statistical analysis of new recommendations for biopsy and biopsies averted after RTUR was performed.

RESULTS

Mean patient age was 57 years (range,17-91). Average time between outside exam and RTUR was 31 days (range, 2-90). Following RTUR, 49 additional biopsies of lesions not originally recommended for biopsy were performed in 43/209 patients (20.1%; 95% CI

14.6-25.6%). 12/49 (24.5%) biopsies yielded cancer in 11/209 patients (5.3%; 95% CI 3.8-6.8%) and 4/49 (8.2%) high-risk lesions in 4/209 patients (1.9%; 95% CI 0-3.8%). 41 biopsies in 32 patients originally recommended were canceled after RTUR. One biopsy was subsequently performed due to ipsilateral multifocal carcinoma. Of 31/209 (14.8%; CI 10.0-19.6%) patients with biopsies averted, 20/31 (64.5%) had 1-year follow-up and 17/31 (54.8%) 2-year follow-up showing stability of RTUR findings. Overall, change in management after RTUR in 68/209 patients (32.5%; 95% CI 26.1-38.9%) yielded 12 additional cancers, 4 high-risk lesions and averted biopsy of 40 lesions.

CONCLUSION

RTUR after reinterpretation of submitted static ultrasound images at a comprehensive cancer center resulted in 49 additional biopsies, detecting 12 additional cancers, 4 high-risk lesions and averted 40 biopsies in 68 patients. RTUR led to a change in management in approximately 1/3 of patients.

CLINICAL RELEVANCE/APPLICATION

Real-time ultrasound re-evaluation after second opinion review of outside breast ultrasound studies can detect additional cancers and high-risk lesions and avert unnecessary biopsies.

SSG01-09 Shear Wave Elastography of the Breast Lesions: Quantitative Analysis of the Heterogeneous Elasticity Improves the Diagnosis Performance

Tuesday, Nov. 28 11:50AM - 12:00PM Room: E451A

Participants
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PURPOSE

To evaluate whether addition of quantitative analysis of the heterogeneous elasticity (Ehetero) could improve the diagnosis performance of shear wave (SW) elastography in breast cancers.

METHOD AND MATERIALS

From October 2015 to February 2017, 239 patients with 255 breast lesions (126 benign, 129 malignant) were enrolled in this study. All lesions were evaluated with ultrasound Breast Imaging Reporting and Data System (BI-RADS) and VirtualTouch IQ shear wave elastography. Three region of interests (ROI) were placed over the highest stiffness or lowest stiffness area of the lesions to measure the SW velocity (SWV), respectively, and low SW quality area was avoided. Ehetero was determined as the difference between the averaged highest SWV and lowest SWV. The cut-off values for SWVmax and Ehetero were 5.06 m/sec and 1.44 m/sec, respectively. The diagnosis performances including area under the receiver operating characteristic curve (AUC), sensitivity, specificity, positive and negative likelihood ratio were determined for BI-RADS, SWVmax and Ehetero.

RESULTS

Ehetero showed the highest AUC (0.953; 95% confidence interval [CI]: 0.924 - 0.983), which was significantly higher than SWVmax (0.938; 95% CI: 0.908 - 0.968) (P<0.001) and BI-RADS (0.705; 95% CI: 0.662 - 0.748) (P<0.001), with a positive likelihood ratio of 19.53 (95% CI: 8.9 - 42.7) and a negative likelihood ratio of 0.07 (95% CI: 0.04 - 0.10). The sensitivity of Ehetero was 93.02% (95% CI: 87.2% - 96.8%), which was significant higher than SWVmax (83.72%, 95% CI: 76.2% - 89.6%) (P<0.001), while there was no significant difference for the specificity between Ehetero (95.24%, 95% CI: 89.9 - 98.2) and SWVmax (92.86%, 95% CI: 86.9 - 96.7) (P=0.375). Twelve of the Ehetero positive cancers were misdiagnosed by SWVmax and none of the SWVmax positive cancers was misdiagnosed by Ehetero. When to downgrade BI-RADS category 4a lesions, 3 of 12 malignancies would be misdiagnosed by using SWVmax along, while only 1 would be misdiagnosed by using Ehetero.

CONCLUSION

Quantitative analysis of the heterogeneous elasticity can improve SW elastography sensitivity in breast cancer detection, without losing of specificity.

CLINICAL RELEVANCE/APPLICATION

When using elastography to downgrade BI-RADS categoray 4a breast lesions, addition of quantitative analysis of the heterogeneous elasticity could decrease misdiagnosis.

SSG02

Cardiac (Coronary Artery Disease: Techniques)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S504AB

CA CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSG02-01 Inter-observer Agreement for the Coronary Artery Disease Reporting and Data System (CAD-RADS)

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S504AB

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PURPOSE

To prospectively evaluate the inter-observer agreement of readers who used CAD-RADS to classify coronary CT angiography (CCTA) exams, including assessment categories and modifiers.

METHOD AND MATERIALS

Four junior readers with less than 5 years' experience, and four senior readers with greater than 5 years' experience prospectively evaluated 50 CCTA cases using the CAD-RADS lexicon. All readers assessed image quality using a five-point Likert scale, with mean Likert score >=4 designating high image quality, and <4 designating moderate/low image quality. All readers were blinded to medical history and invasive coronary angiography findings. Inter-observer agreement for CAD-RADS assessment categories and modifiers were assessed using intra-class correlation (ICC) and Fleiss' Kappa (κ). As a secondary endpoint, inter-observer agreement of high-risk plaque (modifier "V") was examined, including spotty calcification (SC), napkin ring sign (NRS), low attenuation plaque (LAP), and positive remodeling (PR).

RESULTS

Inter-observer agreement among all readers for CAD-RADS assessment categories was very strong (ICC 0.958, 95% CI 0.938-0.974). Agreement among senior readers (ICC 0.925, 95% CI 0.884-0.954) was marginally stronger than for junior readers (ICC 0.904, 95% CI 0.852-0.941). High image quality was associated with stronger agreement (ICC 0.944, 95% CI 0.886-0.974) than moderate/poor image quality (ICC 0.887, 95% CI 0.775-0.95). Overall inter-observer agreement for high-risk plaque (modifier "V") was fair (κ 0.40). There was fair inter-observer agreement for each high-risk plaque feature (κ 0.29 for SC, κ 0.25 for NRS, κ 0.24 for LAP, and κ 0.34 for PR).

CONCLUSION

Reproducibility of CAD-RADS assessment categories and modifiers is strong, except for high-risk plaque (modifier "V") which demonstrates fair agreement. A trend towards lower concordance was observed among junior readers and among cases with moderate/poor image quality.

CLINICAL RELEVANCE/APPLICATION

There is strong inter-observer agreement for classifying coronary CTA exams using the CAD-RADS lexicon, supporting its utility in clinical practice.

SSG02-03 Diagnostic Efficacy of Model-Based Iterative Reconstruction Algorithm in Assessment of Coronary

Artery in Comparison with Standard Hybrid-Iterative Reconstruction Algorithm: Dose Reduction and Image Quality

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S504AB

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PURPOSE

To evaluate the image quality and radiation dose exposure of low-dose coronary CTA (cCTA) study, reconstructed with the new model-based iterative reconstruction algorithm (IMR), compared with standard iDose4 cCTA in patients with suspected coronary artery disease (CAD).

METHOD AND MATERIALS

Fifty-four patients with indication for coronary CT study were prospectively enrolled. Twenty-nine patients (study group) underwent 256-MDCT (iCT elite, Philips) cCTA using low-dose protocol (100kV;aumtomated tube-current modulation with a range of 100-330 mAs; CM volume of 50mL) combined with prospective ECG-triggering acquisition and IMR (Philips). A control group of 25 patients underwent 256-MDCT (Brilliance iCT, Phlips) with a standard prospective ECG-gated protocol (100kV; automated modulation with a range of 200-400 mAs; iDose4 reconstruction) with the same amount of CM. On both CT examinations ROIs were manually placed in the lumen of the coronary arteries to calculate intravessels density, standard deviation of pixel value and signal-to-noise ratio (SNR); subjective image quality was also evaluated by 2 radiologists using a 4-point scale score. Finally radiation dose exposure were quantified as DLP, CDTIvol and ED.

RESULTS

No differences were found in patients characteristics. Mean values of mAs were significantly lower for IMR-cCTA (144 mAs) compared to iDose-cCTA (437 mAs), $p<0.001$. Despite the significant reduction of 60% in radiation dose exposure (DLP: IMR-cCTA 76.7mGy*cm vs iDose-cCTA 195.1mGy*cm; p-value<0.002), we found no differences in the mean attenuation values of the coronary arteries (mean density in LAD: 441.8 HU IMR-cCTA vs 425.6 HU iDose-cCTA; $p=0.34$). We observed a significant higher value of SNR and CNR in study group due to a lower noise level. Qualitative analysis did not reveal any significant differences in diagnostic quality of the two groups (mean score: IMR-cCTA 3.30 vs iDose-cCTA 3.21; $p=0.47$).

CONCLUSION

Low-dose cCTA study combined to IMR reconstruction allows to correctly evaluate coronary arteries disease, offering high quality images and significant radiation dose exposure reduction, as compared to standard cCTA protocol, with 66 sec of reconstruction time.

CLINICAL RELEVANCE/APPLICATION

Low-dose IMR-cCTA study is a valid imaging tool for the assessment of coronary arteries in patients with suspected CAD, allowing a radiation dose sparing of 60%.

SSG02-04 A Tailored Tube-Voltage Adapted Contrast Media Injection Protocol for Coronary CT Angiography

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S504AB

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PURPOSE

While traditionally most CT studies had been performed with a standard 120kVp setting, x-ray tube acquisition parameters are increasingly individualized to the patient body habitus and type of examination. On current generation CT systems this is often accomplished by automated tube voltage selection (ATVS) algorithms. We propose a simple, kVp-tailored contrast media (CM) injection protocol for coronary CT angiography (CCTA) involving ATVS.

METHOD AND MATERIALS

Based on results of a previous phantom study, patients referred for non-emergent CCTA were prospectively enrolled. CCTA exams were performed on a 3rd generation dual-source CT scanner. Based on ATVS, patients were divided into 7 groups and scanned in

10 kVp increments at kVp levels ranging from 70 to 130 kVp. CM (370mgI/mL iopromide) was injected constantly for 12 seconds, adapting the iodine delivery rate (IDR) to the kVp level. Average CM volumes were as follows: 35mL at 70 kVp, 39mL at 80 kVp, 45mL at 90 kVp, 50mL at 100 kVp, 56mL at 110 kVp, 60mL at 120 kVp, and 70mL at 130 kVp. An attenuation value of 250 Hounsfield Units (HU) in the left main coronary artery was considered diagnostic. Contrast-to-noise ratio (CNR) was calculated for each protocol. Subjective image quality was assessed using a 5-point Likert scale.

RESULTS

Diagnostic vessel attenuation was achieved with all protocols in all patients. Mean vessel attenuation was 377 HU at 70 kVp, 355 HU at 80 kVp, 326 HU at 90 kVp, 325HU at 100 kVp, 320 HU at 110 kVp, 306 HU at 120 kVp, and 286 HU at 130 kVp. The 70kVp protocol achieved the highest average attenuation (377 HU), significantly higher than protocols >= 110kVp (P< 0.001). The 80kVp protocol rendered the highest CNR (20.3), comparable to 70kVp and 90kVp (17.9 and 14.3, respectively; P> 0.05), while significant differences were found with >=100 kVp protocols (P> 0.01). No significant differences were found in subjective image quality (P= 0.691).

CONCLUSION

The proposed kVp-tailored CM injection protocol allows for substantial reductions in CM administration while maintaining diagnostic vessel attenuation in CCTA.

CLINICAL RELEVANCE/APPLICATION

Individual tailoring of CM volume administration to the acquisition potential selected by automated tube voltage selection algorithms is feasible, relatively straightforward, and decreases the amount of CM administration required for diagnostic CCTA exams.

SSG02-05 Diagnostic Accuracy Comparison of Low and High Tube Voltage Coronary CT Angiography using Tailored Contrast Medium Injection Protocols

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S504AB

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PURPOSE

To compare the diagnostic accuracy between third-generation dual-source coronary CT angiography (CCTA) using <=100 versus >100 kilovolt peak (kVp) x-ray tube settings and kVp-tailored contrast medium injection protocols with invasive coronary catheter angiography (ICA) as the reference standard.

METHOD AND MATERIALS

We analyzed data of 120 patients (mean age=62.6 years, mean BMI=29.0 kg/m2) who had undergone both invasive catheter angiography as well as CCTA. Subjects were divided into two cohorts (n=60 each) based on CT acquisition x-ray tube voltage (mean kVp=84.3 and 116.5, respectively). The contrast media volume was tailored to the kVp level: 70kVp=40 mL, 80kVp=50 mL, 90kVp=60 mL, 100kVp=70 mL, 110kVp=80 mL, and 120kVp=90 mL. Quantitative contrast-to-noise ratio (CNR) was measured. Two radiologists evaluated image quality and analyzed studies for the presence of significant coronary stenosis (>50% luminal narrowing) in a segment-based fashion.

RESULTS

Sensitivity and specificity for <=100 versus >100 kVp CCTA were: per-patient=93.9 and 92.6% versus 90.9 and 92.6%, per-vessel=91.5 and 97.8% versus 94.0 and 96.8%, and per-segment=90.0 and 96.7% versus 90.7 and 95.2%, respectively, without significant differences (all P>0.64). Quantitative image quality was slightly higher (P>0.18) using lower kVp settings (mean CNR=12.0 and SNR=9.8) versus higher kVp CCTA (mean CNR=11.1 and SNR=8.9). No significant differences were found for subjective image quality among the cohorts (P=0.38). Contrast media requirements were reduced by 38.1% in the low versus high kVp cohort (53.6 vs 86.6 mL, P<0.001). Radiation dose in <=100 kVp was 59.6% less than >100 kVp examinations (4.3 versus 10.6 mSv, P<0.001).

CONCLUSION

Third-generation dual-source CCTA using kVp-tailored contrast injection protocols can be robustly performed at <=100 kVp in an overweight population while maintaining diagnostic accuracy for coronary stenosis detection compared to >100 kVp image acquisition, substantially reducing radiation and contrast dose.

CLINICAL RELEVANCE/APPLICATION

CCTA with tube potential <=100 kV and tailored contrast material adminstration allows for comparable diagnostic accuracy for

stenosis detection but substantial dose savings both in terms of radiation and contrast agent compared to standard image acquisition.

SSG02-06 Single Heart-Beat Coronary CT Angiography on 256-Slice CT Scanner: Comparison of Image Quality between Free Breathing and Breath Holding

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S504AB

Participants
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PURPOSE

To evaluate the difference of image quality of single heart-beat coronary CT angiography (CTA) on 256-slice CT scanner between free breathing and breath holding.

METHOD AND MATERIALS

208 subjects underwent coronary CTA from Dec. 2016 to Feb. 2017 using GE Revolution CT scanner, who were randomly divided into two groups. Subjects of free breathing group were instructed to smoothly breath during scanning. Subjects of breath holding group were instructed to hold breath during scanning. Auto-gating technique was used to determine acquisition cardiac phase and parameters. Collimation was set to 256×0.625mm, 224×0.625mm or 192×0.625mm depending on the size of heart. Single heart-beat acquisition was performed, with tube rotation time 0.28s, tube voltage 100kV, auto-mA and noise index 25. Vessel tracking was used to trigger acquisition on ascending aorta. Acquisition began 9.9s after reaching the threshold of 70HU. The tube exposure for 0.4 to 0.7s. Iohexol 370mgI/ml contrast-media was injected by Ulrich Mississippi injector. Total amount of contrast-media was 40 to 50ml per subject, calculated as 0.86ml/kg. The injection ran 12s. An experienced radiologist independently made 5-scale score for RCA, LAD and LCx. Higher score indicated better image quality. Fisher's exact test was used to assess score difference between two groups.

RESULTS

187 subjects (112 males and 75 females) were included for analysis. 21 were excluded, including 18 unable to reach high injection rate, two uncomfortable feeling and one machine failure. Free breathing group had 79 subjects (63.2±10.1 yo, BMI 24.0±0I9). The score of RCA, LAD and LCx was 4.09±0.92, 4.35±0.75 and 4.35±0.77, respectively. Breath holding group included 108 cases (62.4±9.2 yo,BMI 24.0±3.2). The score was 4.01±0.79, 4.34±0.69 and 4.29±0.79, respectively. The scores between these two groups were not significantly different, where the P value was 0.074, 0.735 and 0.865, respectively.

CONCLUSION

When performing single heart-beat coronary CTA using 256-slice CT scanner, the image quanlity was consistent between free breathing and breath holding method.

CLINICAL RELEVANCE/APPLICATION

Free breathing has the potential to replace breath holding in clinical practice to improve patient cooperation using fast single heart-beat coronary CTA on state-of-art scanner.

SSG02-07 Non-Invasive Evaluation of Coronary Artery Stenosis: In-Vitro Comparison of a Spectral Photon Counting CT and Spectral Dual Layer CT

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S504AB

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PURPOSE

To evaluate if Spectral Photon Counting CT (SPCCT) can enable a better visualization of the arterial lumen in comparison with conventional integrating detector spectral CT (IDSCT) by means of improved spatial resolution and reduced blooming artifacts from calcifications.

METHOD AND MATERIALS

A Plexiglas phantom with 3.0-6.0 mm diameter holes and PVC inserts simulating calcified plaques with remaining lumen between 1.0-3.5 mm was filled with different concentrations of iodine (Iomeron 400, Bracco: 7.1-21.4 mg/ml resulting in 210 to 600 HU enhancement) and scanned on a IDSCT (IQon, Philips) with Standard (SR) and High Resolution (HR) modes and on a SPCCT prototype (Philips), all at 120 kV and 100 mAs. The visibility of the lumen in presence of artificial calcified plaque (CaP) was evaluated by 2 readers for each acquisition on conventional HU and iodine density images using a 5-point Likert scale: 1= Lumen cannot be seen, 2= Lumen seen but diameter and permeability cannot be evaluated, 3= Lumen seen but diameter is hard to evaluate; 4= Lumen seen with smooth edges but can be evaluated; 5= Lumen clearly seen with sharp edges and can easily be evaluated.

RESULTS

Inter-observer reliability was very good (weighted kappa=0.9). On conventional HU images, lumen evaluation improved significantly with SPCCT (median score = 5) compared to IDSCT both in SR (median score = 2, $p < 0.01$) and HR (median score = 3, $p < 0.01$) for all CaP sizes. Changing the iodine concentrations did not change results for IDSCT. Significantly lower grades were found on SPCCT with the lowest iodine concentration compared to the highest one (median score = 3 vs 5, $p = 0.02$) due to high image

noise because iterative reconstruction used on IDSCT was not yet available on SPCCT. On Iodine density images, there was no significant improvement with SPCCT compared to IDSCT SR and HR again due to higher image noise in SPCCT.

CONCLUSION

Evaluation of residual lumen in stenosed coronary arteries with calcified plaques can be significantly improved by using SPCCT.

CLINICAL RELEVANCE/APPLICATION

SPCCT will have the potential to significantly improve the important, but still challenging, non-invasive evaluation of coronary arteries stenosis, especially in presence of calcified plaques.

SSG02-08 Improved Coronary Visualization in High Temporal Resolution Dual-Source Dual-Energy Coronary CT Angiography

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S504AB

Participants
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PURPOSE

Dual energy acquisition may provide additional information over single energy coronary CTA and a high temporal resolution (quarter-scan, 66 msec) reconstruction is available when using dual source CT. However, the 66 msec reconstruction obtained using a third generation dual souce scanner may suffer from blurring artifact as the high kVp data obtained using 150kVp has very little contrast enhancement to guide the fusion of the low and high kVp scans. We compared image noise and image quality obtained using a new prototype reconstruction method (SAF) to the standard method (QAR) in a cohort of subjects undergoing dual energy coronary CT.

METHOD AND MATERIALS

Subjects with familial hypercholesterolemia underwent cardiac DECT as part of a research protocol. Two spatial-frequency selective algorithms were used for reconstructing dual-energy mixed image datasets at 66-ms temporal resolution including the standard method (QAR), as well as a new prototype (SAF) method that reduces the relative contribution of the high-energy spectra and applies a sharper spatial filter. Per-vessel and overall imaging quality were evaluated by two readers based on a 4 point Likert scale . Imaging noise of two algorithms measured using the standard deviation in an ROI in the ascending aorta.

RESULTS

84 vessels in 21 subjects were evaluated. Compared with QAR, the image quality of the LAD and right coronary artery was significantly improved using SAF (2.95±0.59 vs. 2.38±0.74, p=0.003; 3.14±0.72 vs. 2.71±0.90, p=0.013). However, left main and left circumflex imaging scores were similar (2.29±0.72 vs. 2.29±0.46, p=1.000; 2.90±0.70 vs. 2.62±0.86, p=0.166). SAF provided better overall image quality than QAR on a per-patient basis as well (2.57±0.75 vs. 2.95±0.50, p=0.033). Image noise was increased using SAF, but this was not significantly different [57 HU(50-60) vs. 46 HU (42-55), p=0.126].

CONCLUSION

A new high temporal resolution reconstruction method for dual source dual energy CT results in improved image quality, although image noise is non-significantly increased. This method may allow increased adoption of dual energy acqusitions for coronary CT, particularly in patients with higher heart rates.

CLINICAL RELEVANCE/APPLICATION

A new high temporal resolution reconstruction for dual-source dual-energy CT results in improved image quality. This may enable increased adoption of dual energy coronary CT, particularly in patients with higher heart rates.

SSG02-09 Deep Learning Analysis of the Left Ventricular Myocardium in Cardiac CT Images Enables Detection of Functionally Significant Coronary Artery Stenosis Regardless of Coronary Anatomy

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S504AB

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PURPOSE

Fractional flow reserve (FFR), performed during invasive coronary angiography (ICA), is the current reference standard to determine the functional significance of a coronary stenosis. Coronary Computed Tomography Angiography (CCTA) derived virtual FFR is a promising but time and computationally expensive non-invasive alternative that can reduce the number of unnecessary ICA procedures by modeling coronary artery flow dynamics. We propose a method for fully automatic identification of patients with significant coronary artery stenosis based on deep learning analysis of only the left ventricle (LV) myocardium in CCTA.

METHOD AND MATERIALS

The study included resting CCTA scans (Philips Brilliance iCT, 120kVp, 210-300mAs) of 166 consecutive patients (59.2 ± 9.5 years, 128 males) who underwent invasive FFR (0.79 ± 0.10). FFR provided the reference for presence of a functionally significant stenosis (cut-off 0.78) . Automatic analysis first segmented the LV myocardium using a multiscale convolutional neural network (CNN). Next, the segmented myocardium was represented with a number of encodings generated by a convolutional auto-encoder (CAE). To detect local ischemic changes, the LV myocardium was divided into a number of spatially connected clusters. Per-cluster statistics of the encodings were subsequently used by a support vector machine classifier to identify patients with functionally significant stenosis. CCTA scans of 20 patients were used to train the CNN, and an additional 20 scans were used to train the CAE. Accuracy of patient classification was evaluated using the remaining 126 CCTA scans in 50 ten-fold cross-validation experiments. In each experiment, patients were randomly assigned to training and test sets.

RESULTS

Classification of patients resulted in an area under the receiver operating characteristic curve of 0.74 ± 0.02. At sensitivity levels 0.60, 0.70 and 0.80, the corresponding specificity was 0.77, 0.71 and 0.59, respectively.

CONCLUSION

The results demonstrate that fully automatic analysis of only the LV myocardium in resting CCTA scans, without assessment of the anatomy of the coronary arteries, can be used to identify patients with functionally significant coronary artery stenosis.

CLINICAL RELEVANCE/APPLICATION

Deep learning analysis of the LV myocardium could increase the specificity of the clinically used visual stenosis assessment in CCTA and reduce the number of patients undergoing unnecessary ICA.

SSG03

Chest (Dual energy/Radiomics)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S404CD

CH CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSG03-01 Assessment of Regional Xenon-Ventilation, Perfusion, and Ventilation-Perfusion Mismatch Using Dual-Energy Computed Tomography in Asthma-COPD Overlap Syndrome (ACOS): A Comparison with COPD

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S404CD

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PURPOSE

To assess the regional ventilation (V) and perfusion (Q) status in patients with ACOS using combined xenon V and iodine Q dual-energy CT (DECT).

METHOD AND MATERIALS

Fourteen patients with ACOS and fifty-two patients with COPD underwent combined V and Q DECT. Virtual noncontrast image, V and Q maps were anatomically co-registered. After the normalization of V and Q values of each pixel, V/Qratio map was generated. In visual analysis, regional V and Q were determined as decreased, normal or increased, and V/Qratio pattern was determined as matched (-11), or reversed mismatched (V/Qratio<-1) on each maps, in combination of the regional disease patterns including emphysema with or without bronchial wall thickening, bronchial wall thickening and normal on VNC, at each segment. V/Qratio patterns and regional disease patterns were compared between two groups. Quantified CT parameters for V and Q were compared with pulmonary function test in ACOS patient.

RESULTS

The most common structural change in ACOS patients was emphysema with bronchial wall thickening (52.1%), and followed by bronchial wall thickening (27.1%), which were more frequently seen in ACOS patients than in COPD patients ($p < 0.001$). These segments commonly showed matched V/Qratio pattern in ACOS patients, while they commonly showed reversed mismatched V/Qratio pattern in COPD patients ($p < 0.001$). The segments with other structural changes commonly showed matched V/Qratio pattern in two groups. The matched V/Qratio patterns in ACOS patients commonly associated with decreased V and Q, while those in COPD patients commonly showed normal or increased V and Q. Quantified mean V, VQratio and standard deviation of V/Qratio were moderately correlated with 6MWT.

CONCLUSION

Regional V, Q and V-Q relationship can be assessed with combined V and Q DECT in ACOS patients. Regional structural abnormality and V and Q status may be different between the patients with ACOS and COPD.

CLINICAL RELEVANCE/APPLICATION

Regional structural abnormities, ventilation and perfusion status can be assessed simultaneously with combined xenon ventilation and iodine perfusion DECT in ACOS patients.

SSG03-02 Investigation of Regional Pulmonary Perfusion in Acute Lung Injury with Dual-Energy CT

Tuesday, Nov. 28 10:40AM - 10:50AM Room: S404CD

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PURPOSE

To investigate the ability of contrast-enhanced dual-energy CT (DECT) for assessing regional perfusion in a model of acute lung injury (ALI), using dynamic:first-pass perfusion CT (DynCT) as the gold standard. To evaluate if changes in lung perfusion caused by prone ventilation are similarly demonstrated by DECT and:DynCT.

METHOD AND MATERIALS

IRB-approved study, compliant with guidelines for humane care of:laboratory animals. An ALI protocol was applied to 6 landrace pigs. Perfused Blood Volume (PBV) and Pulmonary Blood Flow (PBF) were respectively quantified by DECT and:DynCT, in supine and prone positions. The lungs were segmented in equally-sized regions of interest, namely, dorsal, middle, and ventral. PBV and PBF values were normalized by lung density. Regional air-fraction (AF) was assessed by triple-material decomposition DECT. Per animal:correlation between PBV and PBF was assessed with Pearson's R. Regional differences in PBV, PBF, and AF were evaluated with one-way ANOVA and post hoc linear trend analysis (alpha=5%).

RESULTS

Mean correlation coefficient between PBV and PBF was 0.70 (range: 0.55 to 0.98). Higher PBV and PBF values were observed in dorsal vs ventral regions. Dorsal-to-ventral linear trend slopes (DVLTS) were -10.24 ml/100g/zone for PBV ($p<0.001$) and -223.0 ml/100 g/min/zone for PBF ($p<0.001$). Prone ventilation also revealed higher PBV and PBF in dorsal vs ventral regions. DVLTS were -16.16 ml/100 g/zone for PBV ($p<0.001$) and -108.2 ml/100 g/min/zone for PBF ($p<0.001$). By contrast, AF was lower in dorsal vs ventral regions in supine position, with DVLTS of +5.77%/zone ($p<0.05$). Prone:ventilation was associated with homogenization of AF distribution among different regions ($p=0.74$).

CONCLUSION

DECT-PBV is correlated with DynCT-PBF in a model of ALI, and able to demonstrate regional differences in pulmonary perfusion. Perfusion was higher in the dorsal regions, irrespectively to decubitus, with more homogeneous lung aeration in prone position.

CLINICAL RELEVANCE/APPLICATION

Our results support DECT-PBV as a surrogate for regional pulmonary perfusion in:ALI. Clinically important questions, such as the effectiveness of new drug regimens or ventilation strategies on lung perfusion in ALI could be assessed with DECT-PBV, with lesser radiation burden and extended z-axis coverage as compared with:DynCT-PBF.

Honored Educators

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SSG03-03 Radiomics for Predicting NSCLC Recurrence after Surgery: Quantitative Analysis of the Tumor and Peritumoral Lung Parenchyma on MDCT

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S404CD

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PURPOSE

Surgery is the standard treatment for early-stage non-small cell lung cancer (NSCLC); however, 30%-55% of patients develop recurrence despite resection. We aimed to define recurrence predictors for surgically treated early-stage NSCLC by applying Radiomics analysis to presurgical MDCT images.

METHOD AND MATERIALS

78 early-stage (stages I-IIIA) NSCLC patients who underwent surgery between 2008 and 2013 were retrospectively enrolled. A

follow-up of 3 to 5 years was considered. Tumor recurrence (TR), local recurrence (LR) or distant metastasis (DM), was defined on follow-up MDCT scans. On presurgical MDCT scans we semiautomatically contoured a region of interest (ROI) for the tumor (GTV; gross tumor volume), the peritumoral lung parenchyma (PTV; peritumor volume, 2 cm around the tumor), and the entire lobe(s) where the tumor resided. 88 statistical, morphological, and textural features were extracted from each ROI and analyzed with software developed at our institution. Significative features for univariate Cox analysis were first selected (P<0.05). All possible pairs were then used to build bivariate Cox regressions. Only the pairs that satisfied the proportional hazard hypotheses and whose Pearson's correlation coefficient was between -0.3 and 0.3 were kept. Histopathology, T-stage (T) and N-stage (N) were added as clinical covariates to the best pairs of features. Finally, stepwise regression and performance evaluation methods (bootstrap, k-fold validation, elastic nets) were applied to obtain the best model in terms of receiving operator characteristic curve and area under the curve (AUC).

RESULTS

46 patients remained disease-free; 13 had LR, 19 had DM. The best performances in predicting TR were obtained by combining covariates to morphological and textural features derived from GTV (histopathology+ROI volume+gray level co-occurrence matrix joint maximum) and PTV (N+ROI diameter+zone size) with AUC values of 0.769 and 0.767, respectively. Model based on the lobe analysis (histopathology+ROI center of mass) resulted in AUC value of 0.615.

CONCLUSION

Radiomics, especially utilizing GTV and PTV on presurgical MDCT images, has the potential to predict patient prognosis in surgically treated early-stage NSCLC.

CLINICAL RELEVANCE/APPLICATION

Prognosis prediction in NSCLC using Radiomics and MDCT images could be a useful tool for stratifying patients better at different recurrence risk and defining a personalized treatment.

SSG03-04 Dual-Energy Spectral CT Perfusion Imaging for Differentiating Various WHO Subtypes of Thymic Epithelial Tumors: A Preliminary Study

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S404CD

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PURPOSE

To analyze some conventional computed tomography (CT) features, the quantitative parameters of perfusion and spectral of different WHO subtypes of thymic epithelial tumors(TET) using dual-energy spectral CT.

METHOD AND MATERIALS

81 patients with anterior mediastinal lesions underwent spectral CT perfusion imaging (n=48) and conventional CT enhancement scan (n=33) using Discovery CT750 HD scanner from June 2014 to March 2017 were enrolled in this study. Some morphological features (calcification; multiple nodular ,MN) and the maximal contrast-enhanced range (CEmax) derived from conventional CT scan, the quantitative metrics of perfusion (blood flow, BF; blood volume, BV; mean transit time, MTT; and permeability surface, PS), and spectral scan (water concentration, WC; iodine concentration, IC; normalized iodine concentration, NIC; and spectral HU curve slope, K) on the optimal arterial phase and venous phase of lesions were analyzed. Data statistics was performed using Kruskal-Wallis rank sum test and Spearman's rank correlation analysis.

RESULTS

The mean age of 81 patients with TET was 52.2±9.5 years (31-77 years. Calcification (22/81, 27.2%) could be found in each WHO types, while MN (12/44, 27.3%) only be found in A,AB,B1 and B2 TET. The CEmax values of A and AB TET were significant higher than those of other types (P<0.05). The WC values of A TET in arterial and venous phases were significant higher than those of B1,B2,B3 TET and TC (P<0.05), whereas BF,BV and other spectral parameters showed opposite trends, but without significant correlation between these groups (P>0.05). The PS values of low-risk TET(LRT, including A,AB,B1 TET) and high-risk TET(HRT, , including B2,B3 TET) were significant lower than those of TC, and mild correlation between these three groups were found (r=0.352, P<0.05). The BF,BV and all spectral parameters values of LRT*(A,AB) were significant lower than those of HRT* (B1,B2,B3) and TC. In addition, moderate and mild correlation were found for NIC in arterial phase and venous phase among above three groups, respectively (r=0.422, P<0.05;r=0.363, P<0.05). However, there were no significant difference between HRT*and TC.

CONCLUSION

The quantitative parameters of perfusion and spectral of dual-energy spectral CT perfusion imaging, combined with some conventional CT imaging features, have an important value in identifying different TET pathologic types.

CLINICAL RELEVANCE/APPLICATION

none

SSG03-05 Prediction of Pathological Nodal Involvement by CT-Based Radiomic Features of Primary Tumor in Clinical N0 Peripheral Lung Adenocarcinomas

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S404CD

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PURPOSE

To investigate the potential of CT based radiomic features of primary tumor to predict pathological nodal involvement in clinical N0 peripheral lung adenocarcinomas.

METHOD AND MATERIALS

One hundred and eighty-seven patients with clinical N0 peripheral lung adenocarcinomas who underwent preoperative CT scan and subsequently received lobectomy or pneumonectomy with systematic lymph node dissection were retrospectively reviewed. 219 quantitative 3D features (known as "radiomic features") of the primary lung tumor were extracted; meanwhile, 8 radiological CT features (known as "semantic features") of the primary tumor were evaluated by three radiologists. Univariate and multivariate logistic regression analysis were used to explore the role of semantic features and radiomic features of primary tumor in predicting pathological nodal involvement. The areas under the ROC curves (AUCs) were compared between multivariate logistic regression models.

RESULTS

Of the 187 clinical N0 peripheral lung adenocarcinoma patients, 153 had pathological N0 status and 34 had pathological lymph node metastasis. On univariate analysis, fissure attachment and 17 radiomic features were significantly associated with pathological nodal involvement. Multivariate analysis revealed that semantic features of pleural retraction (p=0.048) and fissure attachment (p=0.023) were significant predictors of pathological nodal involvement (AUC=0.659); radiomic features of F185 (Histogram SD Layer 1) (p=0.0001) was independent prognostic factors of pathological nodal involvement (AUC= 0.73). The logistic regression model produced from combining radiomic feature (F185) and semantic feature (pleural retraction) showed the highest AUC of 0.758 (95% CI: 0.685-0.831), and the AUC value computed by 5-fold cross-validation method was 0.741 (95% CI: 0.0.735 - 0.748).

CONCLUSION

There are significant relationships between semantic features, radiomic features of primary lung tumor and pathological nodal involvement in clinical N0 peripheral lung adenocarcinomas. Prospective identification of predictors for nodal involvement may aid in selecting an appropriate population for lymph node dissection.

CLINICAL RELEVANCE/APPLICATION

Combined evaluation of semantic and radiomic features significantly improves prediction of the risk of a node's involvement with malignancy, and this modality could be easily added to clinical use due to its non-invasive nature.

SSG03-06 Somatic Mutations Drive Distinct Imaging Phenotypes in Lung Cancer

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S404CD

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PURPOSE

Tumors are characterized by somatic mutations that drive biological processes, which are ultimately reflected in the tumor phenotype. Quantitative radiomics non-invasively characterizes tumor phenotypes by using a large panel of automatic image characterization algorithms. However, precise genotype-phenotype interactions through which somatic mutations influence radiographic phenotypes remain largely unknown. Here, we present an integrated analysis of four independent datasets of 763 lung adenocarcinoma patients with somatic mutation testing and quantitative computed tomography (CT) image analytics.

METHOD AND MATERIALS

In univariate analysis, we selected 26 variance retaining independent and stable features by using feature reproducibility (ICC) and PCA based analysis and statistically compared their distributions between mutated and non-mutated cases. We developed multivariate radiomic signatures capable of distinguishing between tumor genotypes in a discovery cohort (n=353) by using mRMR feature selection method and random forest classifier. The performance of the signatures was then validated in the validation cohort (n=352) using AUC. All analyses were performed using Matlab-R2012b and R-3.0.2.

RESULTS

We found sixteen and ten radiomic features to be significantly associated with EGFR and KRAS mutations respectively. We found a

We found sixteen and ten radiomic features to be significantly associated with EGFR and KRAS mutations respectively. We found a radiomic signature related to radiographic heterogeneity that could strongly discriminate between EGFR+ and EGFR- cases (AUC=0.69). Combining this signature with a clinical model of EGFR status (AUC=0.70) significantly improved the prediction accuracy (AUC=0.75). The highest performing signature was capable of distinguishing between EGFR+ and KRAS+ tumors (AUC=0.80) and when combined with a clinical model (AUC=0.81), substantially improved its performance (AUC=0.86). A KRAS+/KRAS- radiomic signature also showed significant, albeit lower, performance (AUC=0.63) and did not improve the accuracy of a clinical predictor of KRAS status.

CONCLUSION

These results suggest that certain somatic mutations drive distinct radiographic phenotypes that can be predicted using radiomics. Such radiomic-based tests can be applied non-invasively, repeatedly, and at low cost, providing an unprecedented opportunity for precision medicine applications.

CLINICAL RELEVANCE/APPLICATION

To establish a link between somatic mutations and the imaging phenotype in a large cohort of adenocarcinoma patients.

SSG03-07 Nodule Texture Predicts Response to Nivolumab Based Immunotherapy for Non-Small Cell Lung Cancer

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S404CD

Participants
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PURPOSE

Nivolumab, a PD-1 inhibitor has shown clinical efficacy in patients with non-small cell lung cancer (NSCLC). It has been approved for treatment of patients with chemotherapy refractory, advanced NSCLC. The current standard clinical approach to evaluating tumor response is sub-optimal in defining clinical benefit from immunotherapy drugs. We sought to evaluate whether computer extracted radiomic features of nodule texture and shape from a baseline CT scan are predictive of response to nivolumab based immunotherapy.

METHOD AND MATERIALS

A cohort of 31 consecutive patients who were treated with nivolumab were included in the study. Patients who did not receive nivolumab after 2 cycles due to lack of response or progression as per RECIST were classified as 'non-responders'; patients who had radiological response per RECIST or had clinical benefit (defined as stable disease >10 cycles) were classified as 'responders'. The study team was provided with CT images from 10 patients who responded to nivolumab, 10 who did not and 11 Cases were blinded for validation. A total of 669 intra-tumoral texture (Gabor, Laws, Haralick) features were extracted and the top 4 features predictive of response on the training set (N = 20) were identified. Within the space of the top features, the optimal decision boundary for separating the training instances was identified via a Quadratic Discriminant Analysis (QDA) approach. The decision boundary was then used to evaluate the test cases (N = 11).

RESULTS

The top ranked features were the entropy, Kurtosis, and Variance of the Gabor texture feature and Variance of the Law-Laplacian feature. The QDA classifier trained with these top 5 features resulted in a 72.72% prediction accuracy on the test set.

CONCLUSION

Radiomic texture features extracted from the nodule on baseline CT scans were found to be predictive of response for NSCLC patients treated with immunotherapy. Multi-site validation is needed to establish the role of these features as predictive biomarker for response to immunotherapy in NSCLC patients.

CLINICAL RELEVANCE/APPLICATION

Our work suggests that we could better identify which patients are most likely to respond to and hence benefit from immunotherapy. From an economic perspective, identifying patients who are not likely to respond to immunotherapy could mean that expensive checkpoint inhibitor drugs would not be needlessly administered to these patients.

SSG03-08 Differentiation of Primary Lung Cancers and Benign Lung Nodules Using CT-Based Radiomic Features

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S404CD

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PURPOSE

To evaluate whether computed-tomography (CT) based radiomic features could differentiate between lung cancers and benign lung nodules.

METHOD AND MATERIALS

120 patients with peripheral lung nodules (<=3 cm) that were non pure ground-glass, and did not display obvious calcification or fat on pre-contrast CT images enrolled in this study. All patients received surgery and the lesions were histologically confirmed (55 adenocarcinomas, 3 squamous cell carcinomas, 20 pulmonary sclerosing hemangiomas, 20 tuberculomas and 22 pulmonary hamartochondromas). 867 radiomic features were extracted from whole-lesion volumetric 3D analysis, and 92 of these which were considered as mutually independent features were included in the analysis. Each feature between lung cancer and benign lesion were compared using two-sample t test or nonparametric Mann-Whitney U test. In order to eliminate errors generated in the process of multiple tests, q-value after the false discovery rate (FDR) correction?less than 0.05 was considered statistically significant. Lasso regression model was used for data dimension reduction and feature selection. Multivariate logistic regression model was built to identify independent factors of differentiating lung cancers and benign lung nodules. Receiver operating characteristic curves (ROC) were generated and the area under the curve (AUC) calculated with histopathology as outcome, then optimal threshold criteria were used to estimate sensitivity and specificity.

RESULTS

53 radiomic features showed significantly statistical differences between lung cancers and benign lung nodules (q<0.05), including 5 First-order statistical features, 23 Texture-based features, 8 LAWS Texture features, 10 Laplace of Gaussian features, and 7 3D Wavelet decomposition. The model generated by 6 radiomic features demonstrated excellent performance in differentiation between lung cancers and benign lung nodule, with an AUC value of 0.908 (95% CI: 0.859 - 0.958) by 10 fold cross-validation. Using the cut-off value of 0.665, the proposed CT-based radiomic feature predictors achieved 81.0% sensitivity, 85.5% specificity and 70.0% accuracy.

CONCLUSION

CT based radiomic features has the potential to differentiate primary lung cancers and benign lung nodules.

CLINICAL RELEVANCE/APPLICATION

CT-based radiomic analysis could provide useful information in the differentiation between lung cancers and benign lung nodules without adding additional cost.

SSG03-09 Radiomic Prediction of Survival in Patients with Rheumatoid Arthritis-Associated Interstitial Lung Disease Based on Hyper-Curvature Model

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S404CD

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PURPOSE

To evaluate the comparative performance of a radiomic hyper-curvature (RHC) model of lung CT images in the prediction of the overall survival of patients with rheumatoid arthritis -associated interstitial lung disease (RA-ILD).

METHOD AND MATERIALS

We retrospectively collected 72 RA-ILD patients with thin-section lung CT and serial pulmonary function tests. The lung regions were extracted from the CT images using our previously developed method, after which the bronchi and aerated lungs were separated using histogram thresholding, region growing and mathematical morphology. To characterize the patients' lungs, we computed 120 RHC features that characterize the principal curvatures, curvedness, light/dark blobs, lines and sheets, and curvature scales of the bronchi and the aerated lungs. An elastic-net penalty method was used to select and combine these RHC features with a Cox proportional hazards model for predicting the survival of the patient. Evaluation was performed by use of bootstrapping with 2,000 replications, where concordance index (C-index) was used as a measure of prediction performance. The performances of the gender, age, and physiology (GAP) model; gender, age, and the RHC model; and GAP and RHC, were compared with that of the RHC by use of two-sided t-test.

RESULTS

Bootstrap evaluation yielded the following C-index values for the combinations of clinical and radiomic features: (a) GAP model: C-index 78.3%, [95% confidence interval (CI): 70.1, 86.5]; (b) RHC model: 80.8% [CI: 71.9, 89.7], P<0.0001 in comparison with (a); (c) gender, age, and RHC: 83.8% [CI: 77.1, 90.5], P<0.0001 in comparison with (b); and (d) GAP and RHC: 87.3% [CI: 81.3, 93.1], P<0.0001 in comparison with (c). Kaplan-Meier survival curves of patients stratified to low- and high-risk groups based on the RHC showed statistically significant (P < 0.0001) difference.

CONCLUSION

The RHC model yielded higher performance than that of GAP model in the prediction of overall survival. Addition of gender and age as well as GAP to the RHC further improved the performance of the RHC. Thus, RHC can be an effective imaging biomarker for predicting overall survival of patients with RA-ILD.

CLINICAL RELEVANCE/APPLICATION

Radiomic hyper-curvature features that are automatically calculated from lung CT images can provide an effective prognostic imaging biomarker for precise management of patients with RA-ILD.

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SSG04

Gastrointestinal (Liver Tumor Imaging)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: E352

BQ GI MR OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSG04-01 Correlation of Molecular Transporter Receptor Expression with Hepatobiliary Phase Signal Intensity in Hepatocellular Adenoma Subtypes on Gd-EOB-DTPA-Enhanced MR Imaging

Tuesday, Nov. 28 10:30AM - 10:40AM Room: E352

Awards
Student Travel Stipend Award

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PURPOSE

To correlate hepatobiliary phase signal intensity (SI) of hepatocellular adenoma subtypes (HCAs) on Gd-EOB-DTPA-enhanced MR with molecular transporter expression.

METHOD AND MATERIALS

In this IRB and HIPAA compliant study, the study cohort comprised of 49 histologically-subtyped HCAs from 21 consecutive patients: 14 inflammatory, 20 hepatocyte nuclear factor-1A-mutated (HNF-1A), 1 B-catenin-activated (BCA), and 14 unclassified (UC). Quantitative MR imaging features, including the SI ratio of the HCA relative to liver on the pre-contrast, arterial, portal venous, equilibrium, and hepatobiliary phases up to 20 minutes were calculated and reviewed by 2 abdominal radiologists. The histologic expression of organic anion-transporting peptide (OATP1B1/3) and multidrug resistant protein (MRP3) of 17 HCAs were compared to the surrounding liver semi-quantitatively using ImageJ software. Continuous variables were assessed using ANOVA and Student's t-test with Bonferroni correction for multiple comparisons.

RESULTS

On hepatobiliary phase, all 49 HCA lesions were hypointense to liver parenchyma with a nadir and plateau SI ratio by 10 minutes. At 20 minutes, the lowest SI ratio was from HNF-1A lesions (0.47±0.09), followed by inflammatory (0.73±0.18, $p<0.001$), UC (0.73±0.06, $p<0.0001$), and then BCA (0.82). On corresponding histology, HNF-1A (n=7) and inflammatory (n=7) HCA subtypes showed reduced OATP1B1/3 staining, with an expression ratio of 0.09±0.03 and 0.40±0.09 respectively ($p<0.001$), while BCA (n=1) had an increased expression ratio (1.2). UC lesions (n=2) showed complete absent OATP1B1/3 staining. There were no specific staining patterns identified with MRP3. Hepatobiliary phase SI demonstrated a strong correlation with OATP1B1/3 expression ($r=0.83$), but had no correlation with MRP3 expression ($r=0.06$). Atoll sign was identified in 2 inflammatory HCAs and correlated with histology to represent a band of cellular overexpression of OATP1B1/3.

CONCLUSION

In our HCA cohort, there was a strong correlation between OATP1B1/3 expression and differential hepatobiliary phase SI, suggesting that Gd-EOB-DTPA uptake may be mediated by OATP1B1/3, but not MRP3.

CLINICAL RELEVANCE/APPLICATION

Because HCAs demonstrate a strong correlation with molecular transporter receptor expression, Gd-EOB-DTPA-enhanced MR may help non-invasively determine HCA genotypic subtype and guide management.

SSG04-02 The Role of Baseline Tumor Enhancement and Apparent Diffusion Coefficient in Predicting Short-Term Response to Treatment in Liver Colorectal Metastatic Lesions: A Volumetric Approach

Tuesday, Nov. 28 10:40AM - 10:50AM Room: E352

Awards
Student Travel Stipend Award

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PURPOSE

To examine usefulness of magnetic resonance (MR) defined volumetric pretreatment enhancement and apparent diffusion coefficient (ADC) to predict short-term response to treatment in patients with liver colorectal metastases

METHOD AND MATERIALS

Liver MR images of 489 patients with colorectal liver metastases (2004-2015) were reviewed retrospectively in this HIPAA compliant study. Fifty-seven patients (154 liver lesions) fulfilled inclusion criteria and were categorized on the basis of the intervention into conventional chemotherapy group (41 lesions), hepatic trans-arterial chemoembolization or TACE group (98 lesions) and Y-90 radioembolization group (15 lesions). Baseline volumetric lesion enhancement in the portal venous phase (PVP), ADC (b value >500) and tumor necrotic volume were calculated employing a prototype software developed by Siemens Healthcare (MR Onco-Treat). Percent change in the largest transverse diameter at 3 month post-treatment was defined according to Response Evaluation Criteria in Solid Tumors (RECIST), and decrease in size by 30% was considered partial response to therapy. SPSS software (ver. 21), student t test and receiver operator characteristic curve analysis were used.

RESULTS

In all three groups a lower pretreatment ADC value, but not enhancement in the PVP or tumor necrotic volume, was significantly predictive of partial response to treatment (conventional chemotherapy: 939.7 x 10-6 mm2/s vs. 1305.4 x 10-6 mm2/s; p=0.01; optimal threshold, 1125 %; sensitivity, 75%; specificity, 69%; TACE: 1100.7 x 10-6 mm2/s vs. 1400.4 x 10-6 mm2/s; p<0.01; optimal threshold, 1244 x 10-6 mm2/s; sensitivity, 70.4%; specificity, 80%; Y-90 radioembolization: 895.6 x 10-6 mm2/s vs. 1140.9 x 10-6 mm2/s; p=0.03; optimal threshold, indefinable).

CONCLUSION

Volumetric baseline ADC could be used as a predictor of response to treatment in patients with colorectal liver metastases. Accordingly, a higher baseline ADC portends a worse outcome.

CLINICAL RELEVANCE/APPLICATION

Baseline volumetric ADC could be used to predict prognosis and tailor treatment strategies individually in patients with metastatic hepatic colorectal lesions.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ihab R. Kamel, MD, PhD - 2015 Honored Educator

SSG04-03 Gadoxetic Acid-Enhanced MRI Outperformed Multidetector CT in Diagnosing Small Hepatocellular Carcinoma Measuring Up to 2 cm: A Systematic Review and Meta-Analysis

Tuesday, Nov. 28 10:50AM - 11:00AM Room: E352

Participants
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PURPOSE

A systemic review and meta-analysis of the diagnostic performance of gadoxetic acid disodium-enhanced magnetic resonance imaging (Gd-EOB-DTPA-enhanced MRI) and multidetector computed tomography (MDCT) was performed in diagnosing small hepatocellular carcinoma (HCC) measuring up to 2 cm(<=2 cm).

METHOD AND MATERIALS

Two investigators searched multiple databases for studies in which the performances of either Gd-EOB-DTPA-enhanced MRI or MDCT were reported with sufficient data to construct 2 * 2 contingency tables for diagnosing HCCs up to 2 cm on a per-lesion or per-patient level. Diagnostic performances were quantitatively pooled by a bivariate random-effect model with further meta-regression and subgroup analyses.

RESULTS

Twenty-seven studies (fourteen on Gd-EOB-DTPA-enhanced MRI, nine on MDCT and four on both) were included, enrolling a total of 1735 patients on Gd-EOB-DTPA-enhanced MRI and 1781 patients on MDCT. Gd-EOB-DTPA-enhanced MRI demonstrated significantly higher overall sensitivity than did MDCT (0.92 vs 0.66, p<0.001), without substantial loss of specificity (0.89 vs 0.91, p=0.354). Area under the summary receiver operating characteristic curve was 0.9712 with Gd-EOB-DTPA-enhanced MRI and 0.8538 with MDCT. Regarding Gd-EOB-DTPA-enhanced MRI, sensitivity was significantly higher for studies originated from non-Asian countries than Asian countries (0.96 vs 0.93, p=0.01), for retrospective studies than prospective studies (0.95 vs 0.91, p<0.01), and for those with Gd-EOB-DTPA injection rate >=1.5ml/s than that of <1.5ml/s (0.97 vs 0.90, p<0.01).

CONCLUSION

Gd-EOB-DTPA-enhanced MRI demonstrated higher sensitivity and overall diagnostic accuracy than MDCT, and thus should be the preferred imaging modality for diagnosing small HCCs measuring up to 2 cm.

CLINICAL RELEVANCE/APPLICATION

Early detection of small HCCs up to 2 cm can improve long-term patient survival. However, limited diagnostic accuracy has been demonstrated by traditional non-invasive imaging modalities including ultrasonography, multiphasic CT and MRI with non-specific contrast agents for the diagnosis of small HCCs. Fortunately, the introduction of MDCT and Gd-EOB-DTPA, a liver-specific hepatobiliary contrast agent, has led to better detection and characterization of small HCCs.

SSG04-04 MRI of Hepatocellular Carcinoma in Non-Alcoholic Fatty Liver Disease: Signal Characteristics and Inter-Rater Agreement

Tuesday, Nov. 28 11:00AM - 11:10AM Room: E352

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PURPOSE

To determine the MRI features of hepatocellular carcinoma (HCC) in the setting of non-alcoholic fatty liver disease (NAFLD)

METHOD AND MATERIALS

In this IRB-approved retrospective review from 1/1/2001 to 12/31/2016, consecutive patients with NAFLD and pathology proven HCC, biopsy proven hepatic steatosis (<=6 months from MRI) and/or hepatic fat signal fraction >= 5% at MRI were selected. HCC and liver parenchyma signal characteristics were independently reviewed by three abdominal radiologists and final features determined by majority. Inter-rater agreement was determined by prevalence-adjusted kappa. Hepatic fat signal fraction (FS %) was independently calculated. FS% was compared by HCC and liver MRI signal characteristics.

RESULTS

49 patients (80% male; mean age 63.3±11.9 years) with mean (±SD) HCC tumor size at MRI of 4.6±3.2 cm were included. HCC features included arterial phase hyperenhancement (APHE) (96%), portal venous phase washout (PVWO) (67%), delayed phase washout (DPWO) (82%), capsule (73%), T2W hyperintensity (90%), T1W hypointensity (65%), diffusion hyperintensity (93%), hepatic steatosis (65%) and cirrhotic morphology (43%). Mean FS% was 8.8 ± 8.4 %. Mean FS% by none, mild, moderate and severe steatosis at imaging: 0.9%, 8.3%, 20.1% and 27.5%, respectively (p<0.001). Mean FS% by mild, moderate and severe steatosis at pathology: 6.6% 11.2% and 21.8%, respectively (p<0.001). Inter-rater agreement was 0.80-0.84 for APHE, 0.47-0.63 for PVWO, 0.63-0.79 for DPWO, 0.35-0.63 for capsule, -0.22-0.22 for hepatic steatosis and 0.43-0.55 for cirrhosis. Agreement between pathology and MRI was 0.59 for cirrhosis. Hepatic FS% by HCC features: 9.1% (APHE) v. 2.1% (No APHE; p<0.02), 6.9% (PVWO) v. 12.5% (No PVWO; p<0.05) and 9.6% (T2W hyperintense) vs. 1.4% (T2W iso/hypointense; p<0.001).

CONCLUSION

A high proportion of HCCs occur in NAFLD without imaging evidence of cirrhosis (~60%) and are therefore not eligible for LIRADs categorization. Up to 20% of HCCs in NAFLD do not demonstrate washout and higher FS% is associated with absent PVWO but not DPWO. Inter-rater agreement is fair to very good for major HCC features at MRI but poor to moderate for hepatic steatosis and cirrhotic liver morphology in patients with NAFLD.

CLINICAL RELEVANCE/APPLICATION

In patients with NAFLD, many HCCs occur in the absence of cirrhotic liver morphology and may not demonstrate portal venous washout, thereby impacting the noninvasive imaging diagnosis of HCC.

Honored Educators

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educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Sudhakar K. Venkatesh, MD, FRCR - 2017 Honored Educator

SSG04-05 Microvascular Invasion of Hepatocellular Carcinoma Predicted By T1 Mapping at Gd-EOB-DTPA Enhanced Magnetic Resonance Imaging: The Role of Texture Analysis

Tuesday, Nov. 28 11:10AM - 11:20AM Room: E352

Participants
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PURPOSE

To explore the value of texture analysis on T1 mapping at Gd-EOB-DTPA enhanced MRI in predicting and grading microvascular invasion (MVI) of hepatocellular carcinoma (HCC).

CONCLUSION

Texture analysis for T1 mapping at Gd-EOB-DTPA enhanced MRI held promise for predicting and grading MVI of HCC.

CLINICAL RELEVANCE/APPLICATION

Texture parameters of T1 mapping at Gd-EOB-DTPA enhanced MRI is related to tumor heterogeneity and the cellular uptake of Gd-EOB-DTPA, and therefore, can be used for HCC aggressiveness evaluation.

SSG04-06 Extent of Portal Invasion in Patients with HCC: The More, the Worse?

Tuesday, Nov. 28 11:20AM - 11:30AM Room: E352

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PURPOSE

Portal vein invasion (PVI) is known to have a significant impact on the prognosis of patients with hepatocellular carcinoma (HCC). Nevertheless, the degree of invasion can vary from sub-/segmental invasion to complete occlusion of the main trunk of the portal vein (PV). The purpose of this study was to evaluate whether the degree of invasion correlates with an impaired prognosis.

METHOD AND MATERIALS

763 patients with HCC were extracted from the clinical registry of our tertiary referral center as an ongoing effort to reevaluate the extent of PVI in all patients treated between 01/2005 - 06/2016. PVI was diagnosed by contrast enhanced CT or MRI. The extent of PVI was documented by the Liver Cancer Study Group of Japan-classification ranging from Vp0-Vp4: Vp0 = no PVI; Vp1 = segmental; Vp2 = right anterior or right posterior PV; Vp3 = right or left PV; Vp4 = main trunk. Median overall survival (OS) was calculated for each Vp-group.

RESULTS

PVI was present in 259 patients, 504 patients showed no sign of PVI. The patients with PVI were classified Vp1 to Vp4 in 12, 35, 88, and 124 cases. The corresponding median OS yielded 5.2, 5.6, 3.9, and 4.6 months for Vp1-Vp4, respectively. There was no significant difference between these PVI-subgroups ($p>0.05$). Median OS without PVI was 37.7 months and was therefore significantly longer compared to the patients with any form of PVI ($p<0.001$).

CONCLUSION

PVI in patients with HCC is associated with a dismal prognosis. However, the extent of PVI itself has no significant impact.

CLINICAL RELEVANCE/APPLICATION

Even a minor PVI leads to a very poor prognosis which has to be taken into account for treatment planning.

SSG04-07 Role of Diffusion Weighted Imaging in Differentiation of Pyogenic Hepatic Abscess from Necrotic Hepatic Metastatic Neoplasm

Tuesday, Nov. 28 11:30AM - 11:40AM Room: E352

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PURPOSE

To analyze the efficacy of DWI in the differentiation of pyogenic hepatic abscess from necrotic hepatic metastatic neoplasm

RESULTS

ADC values in cavity of pyogenic hepatic abscess were significantly lower with than necrotic hepatic metastatic neoplasm(1.61±0.77 vs 2.55±0.52×10-3mm2/s, P =0),which ADC value under the ROC curve (0.869), with a sensitivity of 96.3%, and a specificity of 73.2%.ADC values in cyst wall of two group were not significant(1.44±0.52 vs1.47±0.29×10-3mm2/s,p=0.627).ADC values in normal hepatic parenchyma of two group were not significant(1.61±0.45 vs 1.62±0.5×10-3mm2/s,p=0.865)

CONCLUSION

ADC values in cavity proved to be helpful in differentiation of pyogenic hepatic abscess from necrotic hepatic metastatic neoplasm.

CLINICAL RELEVANCE/APPLICATION

When pyogenic hepatic abscess and hepatic metastatic neoplasm can not be identified for enhanced examination or some patients are unable to perform enhanced examinations due to renal insufficiency or contrast agent allergies,DWI examination proved to be helpful.

SSG04-08 Quantitative Liver Function Reserve Analysis for Hepatocellular Carcinoma with Preoperative Gd-EOB-DTPA enhanced MR Imaging: Validation with Indocyanine Green Tests and Functional Liver Volume

Tuesday, Nov. 28 11:40AM - 11:50AM Room: E352

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PURPOSE

To determine the feasibility of functional liver volume for quantitative liver function reserve analysis in patients with hepatocellular carcinoma by preoperative Gd-EOB-DTPA enhanced magnetic resonance imaging (MRI)

RESULTS

The functional liver volume parameters FV, FV/W and T1HPB /LV (mean value: 879.93, 14.24, 0.18, respectively) were significantly correlated with ICG-R15 (rho=-0.552,-0.486,-0.579; p=0.006,0.019,0.004). T1/LV had the highest correlation with ICG-R15 among all the MRI functional quantitative parameter. The mean valueof rLV, rFV, rFV/W, rT1/LV calculated using virtual resection protocol were 805.89 ml and 546.24, 9.13, 0.29, respectively. Based on Gd-EOB-DTPA liver function reserve analysis, all the patients received standard resection successfully. The Child scores one week after surgery were ranged from 5 to 8 (Child A: n=18,Child B: n=4), except 1 patient suffered serve hepatic insufficiency.

CONCLUSION

It is feasible to assess liver function reserve in patients with HCC before surgery by functional liver volume assessment in Gd-EOB-DTPA MRI combined with volumetric T1mapping.

CLINICAL RELEVANCE/APPLICATION

Instead of ICG test, we provide a new method to assess the liver function reserve using preoperative Gd-EOB-DTPA enhanced MRI.and may facilitate the determination of adopting optimize surgery approach.

SSG04-09 Characterization of Malignancy of Hepatocellular Carcinoma Using Deep Feature with Contrast-Enhanced MR

Tuesday, Nov. 28 11:50AM - 12:00PM Room: E352

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PURPOSE

This study proposes a systematic method to automatically extract deep feature from the arterial phase of Contrast-enhanced MR of hepatocellular carcinoma (HCC) using convolution neural network (CNN) in order to characterize its malignancy. Meanwhile, the performance of deep feature is objectively compared with that of texture features for malignancy characterization.

METHOD AND MATERIALS

Consecutive 46 patients with 46 histopathologically proved HCC were included in the study from September 2011 to October 2015

Consecutive 46 patients with 46 histopathologically proved HCC were included in the study, from September 2011 to October 2015 (43male, 3 female, aged 53.09±12.45 years ranged 27 to 76 years). Gd-DTPA enhanced MR imaging were conducted with a 3T MR scanner. Of the 46 HCCs, one was Edmonson I, twenty were Edmonson II, twenty-four were Edmonson III and one was Edmonson IV (Low grade: I and II; High grade: III and IV). Firstly, each 3D tumor in the arterial phase was multiply resampled in three orthogonal views (Axial, Coronal and Sagittal) independently to increase training sets. Then, each view was performed with CNN to generate corresponding deep feature. Furthermore, a multi-kernel feature learning (MKL) method was investigated to fuse deep features derived from the three orthogonal views in a kernel space. Finally, experiments were conducted to evaluate the performance of the proposed method for malignancy characterization, and also objectively compared with the texture feature-based method with respect to the Axial view. 4-fold cross-validation with 10 repetitions on the 46 HCCs was used to test the proposed framework, in which 33 were randomly selected for training and the remaining 13 for testing.

RESULTS

In Axial view, deep feature (Accuracy: 91.08%±6.83%, Sensitivity: 89.17%±7.22%, Specificity: 92.58%±8.47%) clearly outperformed texture feature (Accuracy: 82.50%±12.70%, Sensitivity:88.89%±11.15%, Specificity: 74.55%±22.01%) in terms of accuracy, sensitivity and specificity. Furthermore, the accuracy of fusion of deep feature from three othogonal views using the MKL framework (97.95%±5.12%) was much better than that of deep feature in single orthogonal views (axial:91.08%±6.83%, Coronal: 76.15%±10.54%, Sagittal: 85.38%±5.68%) for malignancy characterization.

CONCLUSION

Deep feature was verified to be more powerful than the texture feature for malignancy characterization of HCCs.

CLINICAL RELEVANCE/APPLICATION

Deep features outperform texture feature for malignancy characterization of HCC, which may be extensively used for lesion characterization in clinical practice.

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SSG05

Genitourinary (Multiparametric Prostate MRI)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S102CD

BQ GU MR OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Matthew S. Davenport, MD, Cincinnati, OH (*Moderator*) Royalties, Wolters Kluwer nv; ;

Sub-Events

SSG05-01 Feasibility of Quantitative Dynamic Contrast Enhanced MRI Using Low Dose Gadolinium: Comparative Performance with Standard Dose in Prostate Cancer Diagnosis

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S102CD

Participants
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PURPOSE

We investigated whether administration of low doses of Gd for dynamic contrast enhanced (DCE) MRI can be effective as a standard dose in distinguishing prostate cancer (PCa) from benign tissue.

METHOD AND MATERIALS

Patients (n=16) with histologically confirmed PCa underwent preoperative 3T MRI using endorectal and phased array surface coils. DCE-MR images were acquired using two mDixon sequences at 8.3s temporal resolution with a low dose 0.015 and standard dose 0.085 mmol/kg of gadobentate dimeglumine (Multihance, Bracco) bolus injections. Low dose images were acquired for 3.5 min, followed by a 5 min gap before acquiring high dose images for 8.3 min. The data was analyzed by fitting signal intensity with an empirical mathematical model to obtain maximum intensity projection (MIP) and signal enhancement rate (a). Correlations of these parameters between low and standard doses of Gd administered were calculated. Receiver operating characteristic (ROC) analysis was performed to evaluate whether these parameters could distinguish between PCa and benign tissue using whole mount prostatectomy specimens as reference standard.

RESULTS

A moderately significant Pearson correlation for DCE parameters: MIP (0.53) and a (0.58) was found between low and standard doses of Gd. PCa showed significantly increased a compared to benign tissue for low (10.0±5.8 vs 5.1±2.9 s-1), but not for standard dose (4.3±2.2 vs 3.4±1.5 s-1). The ratio of low dose a to high dose a was significantly greater for PCa (2.8±2.3) than for normal prostate (1.6±0.9), suggesting changes in water exchange and T2* effects associated with cancer. Area under the ROC curve for differentiating PCa from benign tissue using a was higher for low dose (0.77, p<0.05) compared to standard dose (0.63, p>0.05). However, there were no significant differences between MIP calculated for PCa and normal tissue at both low (33±12 vs 29±16%) and standard doses (110±49 vs 94±43%).

CONCLUSION

Quantitative DCE-MRI with low Gd dose better distinguishes PCa from benign prostate tissue than standard Gd dose, based on signal enhancement rate. This may be due to water exchange and T2* effects. Further study is needed to find the optimal dose for PCa diagnosis using DCE-MRI.

CLINICAL RELEVANCE/APPLICATION

Prostate cancer diagnosis may be feasible with quantitative DCE-MRI with low dose Gd contrast.

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SSG05-02 Pharmacokinetics Analysis and Prognostic Implications of Hypovascular Prostate Adenocarcinoma on Multiparametric MRI

Tuesday, Nov. 28 10:40AM - 10:50AM Room: S102CD

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PURPOSE

To compare dynamic contrast-enhancement (DCE) parameters and pharmacokinetics analysis of hypo and hypervascular prostate cancer (PCa) as predictors of patient outcome.

METHOD AND MATERIALS

54 men who underwent 1.5T multiparametric (mp) endorectal prostate magnetic resonance imaging (MRI) from January/2012 to March/2014 were enrolled in this HIPPA-compliant, IRB-approved retrospective study. Lesions with signal intensity at least 10% lower than the normal peripheral zone on DCE analysis were called hypovascular (group-1); all others were consider iso or hypervascular (group-2). 2-compartment Tofts model was used for pharmacokinetics analysis. Patients' outcomes (biochemical failure - BF, metastasis, death) were recorded after a minimum 3-year follow-up. Only the index lesion was analyzed. Demographics, Gleason score, PSA, lesion size, mean ADC, Ktrans, Kep, slope and patients outcomes between the groups were compared using the t-test or the Mann-Whitney test. Logistic regressions were used to compare how DCE characteristics, i.e. group-1 or group-2 features, predicted outcomes.

RESULTS

Twelve lesions (22.2%) were hypovascular and 42 (77.8%) were iso/hypervascular. Age (0.40), follow-up time (0.24), mean ADC, and Gleason score (0.08) did not differ between groups. Group-1 had a higher PSA (87.6 vs 24.8; p=0.01) and larger lesions (33.1 vs 19.1 mm; p<=0.001). Pharmacokinetics parameters were lower for group 1, confirming their hypovascular nature (ktrans, 0.041 vs 0.083; p=0.03 and Kep, 0.067 vs 0.177; p=0.04). At multivariate analysis, the hypovascular pattern (group-1) was a predictor of poor outcome (BF or worse, OR=8.08, p=0.02 and metastases or death, OR=8.3, p=0.05).

CONCLUSION

Hypovascular tumors represent a small proportion of PCa, but the feature is an independent predictor of poor outcome.

CLINICAL RELEVANCE/APPLICATION

Hypovascular PCa have worse prognoses, indicating a major role for lesion characterization with dynamic contrast enhancement.

SSG05-03 3T Multiparametric MRI: Comparison of Performance With and Without Endorectal Coil for Prostate Cancer Detection, PI-RADS v2 Lesion Scoring and Staging with Whole Mount Histopathology Correlation in 429 Patients

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S102CD

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PURPOSE

To investigate prostate cancer (PCa) detection & compare the radiological & pathological characteristics of the lesions on 3T multiparametric MRI (mpMRI) with & without endorectal coil (ERC) with whole mount histopathology (WMHP) correlation.

METHOD AND MATERIALS

In this HIPAA-compliant, IRB-approved case control study, we evaluated a cohort of 429 men with prostate cancer who underwent 3T mpMRI from 7/2009 to 12/2016, prior to robotic prostatectomy. The subcohorts with & without ERC were evaluated. Tumor

detection rate was calculated for total & index PCa lesions. The MRI characteristics of true positive PCa lesions, including PIRADSv2 scoring, prostate volume, tumor volume & ADC value & pathology findings including tumor location & staging were evaluated between two groups. Chi-square & Independent sample T tests assessed the significance of discrete & continuous variables using SPSS v24.

RESULTS

A total of 871 consecutive WMHP localized lesions (54.2% clinically significant) in 429 patients with a mean age of 65.4±7 were included in the study cohort. The ERC & non ERC subcohorts comprised 260 patients with 529 lesions & 169 patients with 342 lesions, respectively. Tumor detection rates for overall, ERC & non ERC subcohorts were 49.5% (431/871), 50.3% (266/529) & 48.2% (165/342), & 77.6% (333/429), 78.5% (204/260) & 76.3% (129/169) for overall & index lesions, respectively (p >0.05). The ERC & non-ERC subcohorts detected 35.9% (66/184) & 48.4% (76/157) of anterior lesions (p =0.019), 58% (200/345) & 48.1% (89/185) of posterior lesions (p=0.025), 37.3% (41/110) & 54.4% (62/114) of transition lesions (p=0.010) & 53.7% (225/419) & 45.2% (103/228) of peripheral lesions (p=0.033). The individual lesion ADC, PIRADSv2 score, pathological staging, tumor volume & prostate volume were similar between two groups (p>0.05).

CONCLUSION

3T mpMRI with & without ERC had similar performance for overall & index PCa detection, PI RADS v2 scoring & staging. However, the ERC subcohort had significantly higher detection rates of clinically significant posterior & peripheral PCa lesions & lower detection rates of anterior & transition PCa lesions compared to non ERC subcohort.

CLINICAL RELEVANCE/APPLICATION

Although performance of 3T mpMRI with & without ERC is similar, ERC enables improved detection of posterior & peripheral lesions.

SSG05-04 PIRADS 2 Lexicon Deep Dive: Association between Lexicon Terms and Predictive Values

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S102CD

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PURPOSE

To determine the association between PIRADS v2 lexicon terms and histopathological outcomes in a blinded randomized setting to assess the discriminatory power of these terms.

METHOD AND MATERIALS

120 prostate MRI in patients with subsequent TRUS/MRI biopsy were evaluated in a blinded and randomized setting by two radiologists (>6 years of prostate MRI experience) using a dedicated review software. Lesions were marked and each lesion was characterized with respect to PI-RADS lexicon terms for shape and border. Lexicon terms describing diffusion weighted imaging were included for comparison. Positive and negative predictive values (PPV, NPV) were calculated for each of the terms and reported. A combination of high PPV/NPV was considered favorable for malignant features, a combination of low PPV/NPV for benign features.

RESULTS

A total of 134 lesions were identified of which 82 (61.2%) were positive for prostate cancer on histopathology. Separated by PI-RADS-Score, 5 PI-RADS 1, 37 PI-RADS 2, 14 PI-RADS 3, 29 PI-RADS 4 and 49 PI-RADS 5 lesions were marked and described. Terms denoting the lesions' shape performed as following (PPV/NPV): "round" 36.4%/54.3%, "oval" 40.2%/66.7%, "lenticular" 39.7%/75.0%, "lobulated" 40.3%/73.3%, "water dropshaped" 41.5%/90.9%, "wedge shaped" 35.3%/38.9%, "linear" (benign) 34.1%/9.1%, "irregular" 40.6%/66.7%. Terms describing the lesion s' borders as following: "circumscribed" 32.3%/55.1%, "non-circumscribed" 41.0%/83.3%, "indistinct" 39.4%/62.9%, "obscured" 48.4%/84.6%, "irregular" 40.9%/73.7%, "spiculated" 39.1%/100.0%, "encapsulated" 31.6%/11.8%, "organized chaos" 31.6%/11.8%, "erased charcoal" 41.7%/85.7%. DWI-associated terms: "restricted diffusion" 72.2%/83.8%, "DWI hyperintensity' 83.7%/87.1%, "ADC hyperintense' 37.9%/0.0%, "ADC isointense" 24.8%/10.3%, "ADC hypointense" 88.9%/79.6%.

CONCLUSION

Almost all DWI specific terms had a favorable PPV/NPV profile. In contrast PI-RADS lexicon terms describing lesions shape and border - with the exception of "encapsulated", "organized chaos" and "linear" to describe benign lesions - tended to have less favorable PPV/NPV mostly with a potential to describe but not exclude tumor (high PPV, low NPV). Values for the respective terms indicate areas of improvement, suggesting refinement of these terms.

CLINICAL RELEVANCE/APPLICATION

This study identifies PI-RADS lexicon strengths and weaknesses of PI-RADS terms to be addressed in further iterations of the lexicon with a potential to improve the reporting accuracy.

SSG05-05 Are Post-Contrast Images Really Helpful on Multiparametric MRI for Detection of Clinically Significant Prostate Cancer

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S102CD

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PURPOSE

To evaluate the incremental value of contrast-enhanced images for clinically significant prostate cancer detection on multiparametric MRI (mpMRI) prior to biopsy.

METHOD AND MATERIALS

IRB approved, prospective study. In an 8 months period, all men who underwent prostatic mpMRI in our institution without a prior diagnosis of clinically significant prostate cancer were enrolled. Patients performed mpMRI on a 3-Tesla scanner with a phased array coil using a routine protocol: T2-weighted, diffusion-weighted and dynamic post-contrast enhancement sequences. Two radiologists read images independently, first without, and subsequently including the post-contrast series. The analysis was performed on a sextant basis, and graded on 5-points scale for cancer suspicion. Sensitivity, specificity, PPV, NPV and accuracy for both readers were calculated using biopsy with imaging fusion ultrasound/mpMRI as the gold standard. The level for statistical significance was set at $p < 0.05$.

RESULTS

Of 449 patients enrolled in our study, 102 were submitted to prostate biopsy with US/MRI imaging fusion. Median time between MRI and biopsy was 15 days. Positivity for different levels of suspicion on mpMRI, comparing images without and with contrast, showed no statistically significant difference for both readers (p-values > 0.05). Sensitivity ranged from 64.5 to 77.7%, specificity from 58.9 to 67.0%, PPV from 23.9 to 25.6%, NPV from 91.8 to 92.8% and accuracy from 60.6 to 65.5%, also with no statistically significant difference between both protocols.

CONCLUSION

Our study shows that detection of clinically significant prostate cancer on mpMRI protocols with and without contrast-enhanced sequences were similar.

CLINICAL RELEVANCE/APPLICATION

A prostate MRI performed without contrast is desirable due to its lower cost, faster scanning time and increased safety for a broader range of patients.

SSG05-06 Influence of the Location and Zone of Tumor in Prostate Cancer Detection and Localization on 3T Multiparametric MRI Based On PI-RADS V2 on 39 Sector Segmentation: Correlation with Whole Mount Histopathology (WMHP) in 415 Consecutive Cases

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S102CD

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PURPOSE

To determine 3T mp-MRI for detection & localization of prostate cancer (PCa) using PI-RADS v2 scoring and segmentation stratified by location & zone correlated with whole mount histopathology (WMHP)

METHOD AND MATERIALS

With IRB & HIPAA compliance, we included 415 consecutive men with 3T mp-MRI within 90 days of robotic prostatectomy (RALP) & WMHP. A GU pathologist detected, graded & outlined each PCa lesion. Jointly a GU radiologist & pathologist classified each focus on mp-MRI with each PCa lesion on WMHP as true or false positive. Two other GU radiologists re-reviewed each mpMRI & assigned PI-RADS v2 scores to all previously detected mp-MRI foci and PI-RADS v2, 39 prostate sector model (for location and zone) in

consensus. Both a rigid (RS) & adjusted sector (AS) matching models were utilized to account for fixation related issues.

RESULTS

We analyzed 863 PCa foci & 16,185 prostate sectors. 3T Mp-MRI detected more PCa lesions in the midgland (54.9 % all & 83.1 % index lesions) than in base (42.1% all [p=0.04] & 64.0 % index lesions [p=0.02]) or apex (41.9% all lesions [p=0.001] and 71.4% index lesion [p 0.006]). There was no difference in detection between overall peripheral and transitional zone PCa (50.4 % vs 43.2 % (p=0.2)) or index PCa 79.1 % vs 73.1 % (p=0.2). The highest of PCa localization sensitivity was for midgland PCa vs. base or apical PCa. AS was higher than RS localization for overall (70.8% vs 36.0%) & index midgland PCa match (71.3% vs 43.7%). 3T Mp-MRI had greater sensitivity (p<0.05) of PZ PCa vs. TZ PCa localization for overall PCa (30.28% vs 24.53% by RS, 58.9% vs 51.2 % by AS match) and for index lesions (37.0% vs 29.2% by RS, and 58.4% vs 50.5% by AS match). 3T mp-MRI had similarly high specificity (93.8-98.3.%) for overall and index tumor localization when using both rigid adjusted sector match approaches.

CONCLUSION

Using 3T mp-MRI and the PI-RADS v2, achieved 83.1% sensitivity for detection of index PCa in the mid gland with 98.3.% specificity. Sectoral localization of PCa within the prostate was moderate and was best with an AS vs RS match.

CLINICAL RELEVANCE/APPLICATION

In this largest study to evaluate influence of the location and zone of tumor in PCa detection and localization on 3T mp-MRI with WMHP correlation. We have demonstrated excellent sensitivity and specificity for prostate cancer detection but moderate performance for intraprostatic sectoral localization, which may have implications for focal therapy.

SSG05-07 Comparison of Subjective and Quantitative Shape Analysis for Differentiation of Transition Zone Prostate Cancer (TZ PCA) From Benign Prostatic Hyperplasia (BPH)

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S102CD

Participants
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PURPOSE

TZ PCa overlaps in appearance with BPH nodules on MRI. Shape features favoring TZ PCa in PI-RADS version 2 include: non-circumscribed/spiculated margin with absent hypointense rim and lenticular shape. Reproducibility of these findings may be limited and have not been compared to quantitative analysis. This study compares subjective and quantitative shape analysis for differentiation of TZ PCa from BPH.

METHOD AND MATERIALS

With IRB approval, 22 TZ PCa were compared to 30 consecutive BPH nodules (15 stromal/15 glandular) identified using MRI-radical prostatectomy (RP) mapping. Two blinded radiologists (provided with location of lesions) subjectively evaluated: shape (round/oval vs lenticular), margin (smooth/lobulated or spiculated/irregular) and presence of hypointense rim on T2W-MRI. Radiologists manually contoured lesions which were quantitatively assessed for: circularity (roundness), convexity (lens shape) and number of skeleton branches/junctions (spiculations). Comparisons were performed using logistic regression, accuracy assessed with ROC and inter-observer agreement calculated.

RESULTS

There was no difference in size comparing TZ PCa to BPH (17.8 ± 6.4 vs. 18.7 ± 7.7 mm), p=0.64. Lenticular shape, irregular/spiculated margin and lack of hypointense rim were associated with TZ PCa (p<0.001). Inter-observer agreement was weak to moderate (K=0.32-0.48). Area under ROC curve (AUC) and sensitivity/specificity of shape and margin to diagnose PCa were: 0.77; 32.2%/100.0% and 0.89; 81.8%/96.7%. Hypointense rim showed AUC=0.89 with sensitivity/specificity of 70.3%/93.3% for diagnosis of BPH. There were significant differences in circularity and convexity (p<0.001) with no difference in number of branches comparing PCa to BPH (p=0.36). There was excellent agreement between readers with low mean difference. Circularity and convexity were accurate for diagnosis of PCa with AUC and SENS/SPEC of: 0.98; 95%/90% and 0.85; 73%/97%.

CONCLUSION

Lenticular shape is specific but insensitive for diagnosing TZ PCa with weak inter-observer agreement. Comparatively, quantitative shape features (circularity and convexity) showed higher accuracy and inter-observer agreeement. Irregular/spiculated margin and lack of hypointense rim are accurate features of TZ PCa.

CLINICAL RELEVANCE/APPLICATION

Quantitative shape analysis improves accuracy and reproducibility for diagnosis of TZ PCa compared to subjective analysis.

SSG05-08 Validation of a Prospective Quantitative Evaluation of Gleason Score Prediction Using Prostate Diffusion Weighted Imaging: A Single Institution Experience in 293 Men with a Clinical Suspicion of Prostate Cancer

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S102CD

Participants
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PURPOSE

To evaluate the potential of prostate diffusion weighted imaging (DWI) for Gleason score (GS) prediction in men with a clinical suspicion of prostate cancer.

METHOD AND MATERIALS

A total of 315 men with a suspected prostate cancer (PCa) based on elevated PSA (2.5 - 20.0 ng/ml) were enrolled in single institutional registered clinical trials between March 2013 and March 2017. Three tesla biparametric MRI (bpMRI) was performed using surface array coils and consisted of T2-weighted imaging (T2w) and three separate epi read-out based diffusion weighted imaging (DWI) acquisitions (5 b values 0-500 s/mm2, 2 b values 0-1500 s/mm2, 2 b values 0-2000 s/mm2). The probability of a suspicious lesion containing Gleason grade 4 was prospectively assigned based on the apparent diffusion coefficient (ADCm) maps calculated using a monoexponential fit and 5 b-values in the range of 0 to 500 s/mm2. This probability was expressed as a Gleason grade score (GGS): 1. unlikely- ADCm above or equal to 850 x 10-6 mm2/s, 2. probable: ADCm below 850 x 10-6 mm2/s 3. highly probable- ADC below 750 x 10-6 mm2/s. All bpMRI reports were reported and/or approved by one reader before biopsy.

RESULTS

Two hundred ninety three (293/315, 93%) men completed bpMRI and subsequent biopsy procedure. GGS could not be assigned in 7 men (2%, 7/293) due to susceptibility artefacts. GGS of 1, 2, and 3 were found in 53% (152/286), 17% (48/286), and 30% (86/286) of men, respectively. PCa with GS of 3+3, 3+4, >3+4 was present in 14% (41/286), 24% (69/286), and 30% (86/286) of men, respectively, while targeted and systematic biopsy cores were free of cancer in 97 men (34%, 97/293). In 58% (88/152) and 18% (28/152) of men with GGS 1 no PCa and GS 3+3 was found, respectively, in contrast to 2% (2/86) and 8% (7/86) of men with GGS 3 ($p<0.001$). The negative predictive values of GGS 1 for GS >3+4 was 88% while positive predictive value of GGS 3 was 60%. The corresponding values for GS equal to or higher than 3+4 were 76% and 90% for GGS 1 and GGS 3, respectively.

CONCLUSION

Our newly developed system for GS prediction demonstrated high negative and positive predictive values for clinically significant prostate cancer in men with a clinical suspicion of prostate cancer.

CLINICAL RELEVANCE/APPLICATION

Prostate diffusion weighted imaging (DWI) performed as a part of biparametric MRI, T2-weighted imaging and DWI acquired using "low" and "high" b values, has a potential to predict the Gleason score.

SSG05-09 Characteristics of PI-RADS 4 Lesions within the Prostatic Peripheral Zone: A Retrospective Diagnostic Accuracy Study Evaluating 170 Lesions

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S102CD

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PURPOSE

To assess whether lesion shape, margination within the peripheral zone, or PI-RADS v2 diagnostic criteria impact accuracy in the detection of clinically significant cancer within the peripheral zone.

METHOD AND MATERIALS

This was an IRB-approved, HIPAA-compliant, retrospective diagnostic accuracy study to evaluate a subset of peripheral zone (PZ) lesions identified on multiparametic prostate MRI (mpMRI) at our large academic medical center. Our prospectively maintained mpMRI database was queried for all PI-RADS 4 (PR4) lesions reported over a 16-month period. Following pre-determined exclusion criteria, 170 PR4 PZ lesions (149 mpMRIs) were reviewed by two faculty abdominal radiologists, blinded to inter-reader assessment and pathologic outcome. Readers classified each lesion based on shape, margination within the PZ, and basis for PR4 score. Lesions were classified as: PR4 by a DWI score of 4, PR4 by a DWI score of 3 + early enhancement, or not meeting PR4 criteria. Lesions not meeting PR4 criteria (n=22) were excluded from the analysis of the remaining variables. All lesions within the study met the reference standard of MR-Ultrasound fusion biopsy. The primary outcome measure was detection of Gleason >= 7 prostate cancer. Logistic regression analysis and chi^2 testing were used for statistical analysis.

RESULTS

Oval shaped lesions were most strongly associated with clinically significant prostate cancer with a PPV of 59.4% (19/32 [p=0.03]). PR4 lesions with a DWI score of 4 were more likely to represent clinically significant prostate cancer than those with a DWI score of 3 + early enhancement (p=0.04). Lesions that did not meet PR4 criteria were statistically less likely to represent Gleason >= 7 prostate cancer (p=0.02).

CONCLUSION

PR4 PZ lesions with an oval shape or DWI score of 4 are more likely to represent clinically significant prostate cancer than the population of all PR4 lesions. Additionally, strict adherence to PI-RADS v2 criteria in classifying PZ lesions leads to exclusion of

lesions that are statistically less likely to represent clinically significant cancer.

CLINICAL RELEVANCE/APPLICATION

This study highlights a subset of PR4 lesions within the PZ that are associated with a higher probability of clinically significant prostate cancer. These findings may help radiologists in determining the suspicion of a given prostatic lesion and may help urologists in management of discordant targeted biopsies.

SSG06

Health Service, Policy and Research (Quality)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S104B

HP SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 0

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Sub-Events

SSG06-01 Clinical Access to Radiology Reports: The Value of the Radiologist

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S104B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The value of radiology is an important topic as hospitals look to curb costs and improve patient outcomes. The radiology report is considered, at least by radiologists, to be instrumental in the imaging value chain. Additionally, in bundled payment schemes, the proportion of funds allotted to different specialties depends on perceived value. The radiology report is considered, by many, to be instrumental in the imaging value chain. Yet, few studies have identified who actually views the reports (i.e., who considers the reports valuable). We sought to determine if reports are viewed and by whom.

METHOD AND MATERIALS

Through our institutional clinical research center, image ordering data were retrospectively identified for a one month time period at a single quaternary care academic medical institution, as well as its satellite inpatient hospitals and outpatient clinics. Provider credentialing data was matched to the ordering data. Statistical analysis was then performed.

RESULTS

31,493 imaging orders occurred for 18,547 unique patients over a one month time period. At 5 months follow-up, 24,204 (77%) of all reports were viewed while 7,289 (23%) were never viewed. Outpatient providers were significantly ($p<0.001$) more likely to never view the report (33% of the time) compared to both emergency room and inpatient providers (17% and 11%, respectively). Departments significantly more likely to not view study reports included orthopedics (31%), neurology (28%), and internal medicine (28%).

CONCLUSION

Review of radiology reports varies by department and provider level. Over one in five reports were never viewed, which has both cost and safety implications for the healthcare system, as well as further questions the value of the radiologist to those departments or providers with high non-viewing rates.

CLINICAL RELEVANCE/APPLICATION

These findings may allow for targeted value improvement projects to expand the radiologist's role and provide more value to the healthcare system.

SSG06-02 A Checklist Manifesto: Effectiveness of Checklist Use in Hands-on Simulation Examining Competency in Contrast Reaction Management and Conflict Resolution

Tuesday, Nov. 28 10:40AM - 10:50AM Room: S104B

Awards
Student Travel Stipend Award

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PURPOSE

To assess the performance of a contrast reaction management (CM) checklist for optimal management of a contrast reaction scenario and conflict resolution using high-fidelity hands-on simulation in a randomized case-controlled study to prevent mortality and morbidity.

METHOD AND MATERIALS

A safety checklist (CL) was designed depicting the 5 most common adverse events after administration of intravenous contrast and their step-by-step management. After IRB approval, informed written consent was obtained from all participants. Forty-three radiology residents (PGY2-5) were randomized into CL (n=22) and control (n=21) groups, stratified by PGY. Both teams received CRM training 2-6 months prior to the study. Participants took written multiple choice question (MCQ) tests 2 months prior and immediately after the high-fidelity simulation scenario which were videotaped and independently evaluated by 3 graders. Built into the scenario was a confederate suggesting an improper medication treatment. The two groups were compared using the Wilcoxon rank-sum test.

RESULTS

Both groups scored similarly on the MCQ tests before the simulation (77% vs. 80%, p=0.4). The CL group overall scored significantly higher than the control group in their overall management of a severe contrast reaction (85% vs. 65%, p=0.002), particularly in first line treatment of bronchospasm (96% vs. 90%, p=0.03) and correct route and dose of epinephrine administration (77% vs. 46%, p=0.02). The CL group also tended to score higher at resolving the conflict when challenged by an authority with incorrectly suggested management (48% vs. 39%, p=0.08). There was no significant difference in MCQ test scores after the scenario between the groups (87% vs. 85%, p=0.6), though there was a trend towards more improvement in the CL group than the control group (p=0.07).

CONCLUSION

A standardized CM checklist is able to reduce the number of treatment errors during a severe contrast reaction management simulation, particularly the proper administration of epinephrine and treatment of bronchospasm. This could be used by radiologists, technologists, and nurses to improve patient safety for both CM and teamwork skills.

CLINICAL RELEVANCE/APPLICATION

Less experience in contrast reaction management (CM) can result in morbidity and mortality. A standardized CM checklist approach has potential to save lives in the event of a severe contrast reaction.

SSG06-03 Evaluation of Educational Sessions and the Use of the Radiology Support, Communication, and Alignment Network Platform in Reducing Inappropriate Imaging for Uncomplicated Low Back Pain

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S104B

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PURPOSE

The aim of this study is to evaluate the impact of educational sessions informing referring physicians on imaging guidelines for low back pain (LBP) on reducing inappropriate lumbar spine MRIs for uncomplicated LBP through the use of American College of Radiology's (ACR's) Radiology Support, Communication, and Alignment Network (R-SCAN) platform.

METHOD AND MATERIALS

Educational presentations were given at 3 clinics in April to May of 2016, which highlighted American College of Physicians and Choosing Wisely Campaign imaging guidelines for LBP, the R-SCAN platform, and its clinical decision support (CDS). Pre-implementation period was defined as June 1st, 2015 to March 31st, 2016. Post-implementation period was defined as June 1st, 2016 to March 31st, 2017. Wilcoxon signed rank test compared the mean monthly MRI orders from all 3 clinics during pre- and post-implementation period. Paired t-test compared the ACR Appropriateness Criteria Rating of MRIs ordered during pre- and post-implementation period. Chi-square test compared the proportion of appropriate MRIs based on the InterQual criteria and the criteria used by Center for Medicare and Medicaid Services on claims data (CMS-NQF criteria). Chi-square test additionally compared the frequency of physical therapy referrals for LBP during pre- and post-mplementation. A p value < 0.05 was considered statistically significant.

RESULTS

The average monthly number of lumbar spine MRI orders for LBP per clinic following implementation was 6.13, which was

significantly lower than the average of 10.33 prior to implementation (p=0.013). The mean ACR Appropriateness Criteria Rating of lumbar spine MRI following implementation was 5.79, which was significantly higher than the mean rating of 4.67 prior to implementation (p=0.014). There were no significant differences in the proportion of physical therapy referrals and appropriate MRIs based on InterQual or CMS-NQF criteria before and after implementation.

CONCLUSION

The R-SCAN platform may be an effective tool to encourage collaboration between radiologists and referring physicians in reducing the proportion of inappropriate lumbar spine MRIs in patients with uncomplicated LBP.

CLINICAL RELEVANCE/APPLICATION

The R-SCAN platform allows referring clinicians to gain familiarity with the CDS process and prepare them for potential implementation of federal reimbursement requirements for CDS consultation in the era of value-based health care.

SSG06-04 Does the Probability that Radiologists Categorize Liver and Kidney Masses as Indeterminate for Malignancy Depend on the Organ, the Radiologist, or Exam Volume?

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S104B

Participants
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PURPOSE

Imaging findings indeterminate for malignancy are commonly detected in the liver and kidney. We explored whether the probability of categorizing indeterminate findings for an individual radiologist was related to the organ, the radiologist or their exam volume.

METHOD AND MATERIALS

The radiology department at our main hospital uses a standardized assessment scheme to categorize imaging findings in the liver and kidneys as benign, indeterminate for cancer, or suspicious for cancer on all US, MR and CT exams. We generated galaxy plots to estimate the probability that an individual radiologist would categorize an indeterminate finding in the liver (i.e. X axis) and kidney (i.e. Y axis) by exam volume. Dashed lines within each plot represent the mean probability across all radiologists. Estimates for high volume radiologists have higher precision, represented by smaller ellipses, than low volume radiologists. We included all exams performed between July 2013 and June 2015. We excluded non-abdominal imaging radiologists and those who interpreted less than 100 exams from analyses for individual modalities.

RESULTS

26 radiologists detected indeterminate masses in the liver or kidney on 7% (370/5,534) and 7% (353/5,068 kidney) of US exams, 3% (350/10,637) and 2% (182/10,659) of MRI exams, and 4% (1,294/ 32,199) and 3% (1,119 / 32,368) of CT exams. The probability that a radiologist would categorize an indeterminate mass in the kidney was directly correlated to the probability in the liver for all modalities; in other words most ellipses lay along a straight line from the bottom left corner through the intersection of the dashed lines. In general, high volume radiologists (i.e. small ellipses) had lower probability of assigning indeterminate masses in either organ on all modalities than high volume radiologists (i.e. large ellipses).

CONCLUSION

Radiologist categorization of indeterminate masses in the liver and kidney may be organ independent. High volume radiologists are less likely to categorize masses as indeterminate than low volume radiologists.

CLINICAL RELEVANCE/APPLICATION

The probability of categorizing indeterminate abdominal masses may be inherent to radiologists. Low volume radiologists may benefit from targeted education.

SSG06-05 Shedding Light on the Off-Hours Coverage Gap in Radiology: Improving Critical Results Reporting and Turnaround Times

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S104B

Participants
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PURPOSE

To demonstrate the magnitude of patient safety gains achieved through radiologist staffing changes at a academic medical center in terms of reporting turnaround times and reporting critical findings.

METHOD AND MATERIALS

A Kaizen event engendered a subspecialty team-based evening shift staffing plan. Inpatient reporting turnaround and critical results communication (CRC) times were evaluated before and after plan implementation. Pneumothorax on x-ray and intracranial hemorrhage (ICH) on CT in 2015 before implementation and in 2016 after implementation were identified using Primordial dashboard (Primordial, San Mateo, CA). CRC was extracted for each case. CRC and number of studies meeting the institutional CRC target goal of 60 minutes were compared before and after late-shift implementation for cases within the late-shift coverage using Mann-Whitney U test and chi-square test, respectively; as control the same parameters were also compared for cases outside the late-shift coverage timings. IBM' SPSS package (ver. 24) for used for statistical analysis.

RESULTS

No significant difference CRC for pneumothorax outside the late-shift (4-8 PM) ($p = 0.6$; before coverage: median: 143 mins, n = 133; after coverage: median: 123 mins, n = 121) was observed. There was a significant late-shift pneumothorax CRC reduction ($p = 0.02$; before coverage: median: 853 mins, n = 31; after coverage: median: 30 mins, n = 25) and a significant difference in the proportion of pneumothorax cases meeting the 60-minute target goal (52%) during the late-shift compared with 33% outside the late-shift ($p = 0.003$). For ICH, similar trends were observed with no significant difference in CRC for cases outside the late-shift ($p = 0.3$; before coverage: median: 81 mins, n = 91; after coverage: median: 182 mins, n = 107) and a significant difference in CRC for late-shift cases ($p < 0.001$; before coverage: median: 112 mins, n = 66; after coverage: median: 22 mins, n = 93). Similarly, there was a significant difference in the proportion of ICH cases meeting the 60-minute goal (57%) during late-shift coverage compared with 42% outside late-shift coverage ($p < 0.001$).

CONCLUSION

Matching staffing to inpatient imaging workflow patterns improves the management of critical findings and imaging findings in general with improved turnaround times.

CLINICAL RELEVANCE/APPLICATION

Inpatient delays present a major patient safety problem remediated through staffing improvements.

SSG06-06 Transition to 24/7/365 In-House Faculty Coverage: Improving Patient Quality and Safety While Maintaining the Integrity of Resident Education

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S104B

Participants
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PURPOSE

24/7/365 in-house faculty radiologist coverage is steadily becoming the new norm in academic departments. To address increased expectations of our emergency department, demands from surgical specialties and hospitalists, and our desire to provide accurate, final overnight reads, our academic department transitioned to such a call paradigm during 2016, abandoning the traditional independent house staff overnight call model. The desire to optimize radiology services, thereby improving quality and patient safety, was considered in concert with maintaining high-quality, rigorous resident training. In order to prioritize resident training while modifying our system of overnight call coverage, we gathered opinions and perceptions from resident trainees prior to the call transition and then again six months following the implementation of the new call model.

RESULTS

Twenty-seven of 32 (84%) residents responded to the initial survey gathering opinions and perceptions regarding resident education in advance of the call change. A majority of respondents (85%) predicted that the number of cases primarily interpreted by residents would decrease as a result of the presence of in-house faculty. Additionally, half of the resident trainees believed the development of autonomous resident decision making would be delayed as a result of in-house call supervision. In terms of one-on-one teaching at the workstation, 62% of residents felt that there would likely be more time for teaching with overnight faculty working in the reading room. New requirements for expedited turnaround times for initial or "wet" reads were viewed as likely favorable for patient care by 46% of those surveyed. Finally, 42% of the residents felt that non-subspecialty overnight reads were somewhat bad for patient care, while 50% viewed the practice as "neutral".Six months after the initiation of new call system, the resident trainees were invited to participate in a follow-up survey. Twenty-seven of 32 (84%) residents participated. Well over half (67%) of the trainees felt that the presence of in-house faculty did not change the number of cases primarily and independently interpreted. Similarly, 63% of respondents felt that the new system of call coverage did not affect the development of autonomous decision making or problem solving. In addition, 48% of residents experienced increased teaching and learning opportunities at the workstation. It was the opinion of 60% of residents that patient care had improved as a result of faster report turnaround time and overall increased resident supervision. Lastly, 52% of the residents would prefer to have subspecialty faculty render the final reads on exams.

CONCLUSION

As 24/7/365 in-house faculty coverage becomes the norm in academic radiology departments, being cognizant of factors contributing to successful resident training is essential. As our department prepared to initiate a new call model with around the clock in-house faculty, we gathered data regarding resident attitudes and predictions concerning education, patient care and report quality. Six months following the start of the new call protocol, we resurveyed our trainees to assess their subjective initial experience. Overall, the new call paradigm has been favorably received with the majority of residents feeling that there is no delay in the development of autonomous decision making and problem solving skills. Additionally, nearly half felt that there was more time at the workstation for one-on-one teaching compared with the previous system of overnight call. Residents also have favorable opinions regarding effects on patient care quality as a result of the presence of in-house overnight faculty, although were somewhat divided on having non-subspecialty radiologists issue final reads.

METHODS

Our thirty-two Diagnostic Radiology residents were invited by email to respond to an anonymous online survey in advance of changes to traditional independent house staff overnight call being replaced by 24/7/365 in-house faculty call coverage. The initial survey consisted of eleven single answer questions regarding opinions on the preferred work location of overnight in-house staff, as well as questions related to the anticipated effects of the new in-house faculty overnight coverage on resident call case volume, development of resident autonomous decision making, opportunities for teaching at the workstation, in addition to perceived effects on patient care and safety related to accelerated report turnaround time and final reads authored by non-subspeciaists. Six months following the implementation of the new call system, a follow-up resident survey consisting of eight questions gathering subjective opinions regarding the effects of the new call system on call case volumes, perceived development of autonomous decision making, opportunities for teaching at the workstation and the perceived effects on patient care and report quality was sent by email invitation.

PDF UPLOAD

https://abstract.rsna.org/uploads/2017/17001362/17001362_c7eu.pdf

SSG06-07 Radiology Report Recommendations: An Actionable Value-Add?

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S104B

Participants
Bettina Siewert, MD, Brookline, MA (*Presenter*) Reviewer, Wolters Kluwer nv
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PURPOSE

To investigate whether recommendations given in radiology reports contain specific, actionable information for the ordering physician.

METHOD AND MATERIALS

In this IRB approved, HIPAA compliant study, we performed a search of our PACS database for abdominal CT reports containing report recommendations from 1/8/15-11/7/15. Recommendations were categorized into: immediate further imaging work-up, follow-up imaging in 1-24 month, referral to subspecialist, correlation with laboratory testing, clinical correlation, correlation with prior outisde imaging, follow-up only if clinically indicated. If further imaging evaluation was recommended, the modality and time interval for follow-up were noted.

RESULTS

11,520 CT examinations of the abdomen and pelvis were performed during the study period. 1,129 (9.8%) examinations contained a report recommendation. Percentage of report recommendations by staff member varied from 5.4-16.1%. The following action items were recommended: immediate further imaging evaluation of a suspected diagnosis n=466(41.3%), follow-up imaging at time intervals of 1-24 month n=261(23.1%), referral to subspecialist n=128(11.3%), repeat imaging due to technical issues n=6(0.5%). Additional recommendations (n=88,7.8%) included: correlation with laboratory testing (n=25), clinical correlation (n=28), correlation with prior outside imaging (n=35). 52 (4.6%) reports recommended imaging follow-up only if clinically indicated. A choice of imaging modality was given in 71 (6.3%) and of time interval in 72 recommendations (6.3%), time interval for follow-up was not specified in 48 recommendations (4.3%).

CONCLUSION

9.8% of abdominal CT reports contain a report recommendation. 72.1% of recommendations provide the ordering physician with specific actionable information. Attention to specifying follow-up recommendations in regards to imaging modality, follow-up interval and clinical scenario could improve 27.9% of reports.

CLINICAL RELEVANCE/APPLICATION

27.9% of report recommendations do not include all necessary information needed to be actionable for the ordering physician.

SSG06-08 Patient Satisfaction and Imaging Volume in Outpatient MRI

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S104B

Participants
Xuan V. Nguyen, MD,PhD, Columbus, OH (*Presenter*) Nothing to Disclose
Amna A. Ajam, MD, MBBS, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose
Elvira V. Lang, MD, Brookline, MA (*Abstract Co-Author*) Founder and President, Hypnalgesics, LLC;

PURPOSE

Patient satisfaction is often regarded as a quality endpoint, but information acquired from satisfaction surveys may also provide insight into patients' preferences, especially when relative excess in imaging capacity allows patients greater flexibility in choosing where they undergo imaging. In this study, we test the hypothesis that the distribution of patient visits among MRI sites is influenced by factors affecting patient satisfaction.

METHOD AND MATERIALS

Outpatient MRI visits at a 10-site university-affiliated hospital system were analyzed during a 1-year period in which system-wide MRI volume gradually declined (April 2015 through March 2016). The study encompassed 42,236 MRI examinations total. Sites were classified as having "decreasing", "stable", or "increasing" volume trend using an average quarterly volume change threshold of 5%. Based on 1314 completed Press Ganey outpatient services surveys of MRI visits during the study period, net changes in each site's

satisfaction scores from the baseline fiscal quarter (Q4 FY15) were calculated. Effects of volume trend and fiscal quarter on satisfaction score changes were evaluated by two-way ANOVA.

RESULTS

Volume trend was stable at 6 of the 10 sites, increased at 1 site (by 18% per quarter), and decreased at 3 sites (by 10-24% per quarter). In the latter 3 quarters, average net change in satisfaction scores (from baseline [Q4 FY15]) at sites with decreasing volume were consistently negative and lower than at sites with stable or increasing volume. ANOVA shows statistically significant main effects of volume trend on net score changes for multiple subsections of the satisfaction survey: Overall Assessment ($p<0.03$), Facility Section ($p<0.006$), Personal Issues ($p<0.002$), Registration Section ($p<0.0001$), and Test or Treatment ($p<0.03$).

CONCLUSION

Patient satisfaction and patient volume at MRI imaging sites are interrelated, and patient experiences or perceptions of quality of care may influence decisions regarding what imaging sites are preferentially utilized.

CLINICAL RELEVANCE/APPLICATION

Patient satisfaction with imaging experiences may have operational importance beyond being a quality metric due to its potential impact on imaging volume.

SSG06-09 Reading Room Huddles: An Initial Experience

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S104B

Participants
Stephanie B. Wagner, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Sarah S. Milla, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Chad A. Holder, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Nadja Kadom, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

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PURPOSE

In our pediatric neuroradiology section it has become difficult to remind everyone of our performance goals on a daily basis, especially given presence of rotating trainees. Here, we report our initial experience of using a reading room huddle to communicate our daily section goals.

METHOD AND MATERIALS

A huddle form was created listing our Time Goals (attending arrival by 8:30 am, signing overnight studies by 11 am, hand-off with neuroradiologist on call at 4:50 pm, concluding service at 5 pm); Resource Availability (faculty, fellow and resident leave throughout the day, coverage for fetal MRIs); and Operational Functionality (determine who can protocol CT and MRI studies, check sedated studies, consult with clinicians (Figure 1). A survey was sent to assess the impact of the huddle, its strengths, and areas for improvement.

RESULTS

The huddle was performed on 23 weekdays since March 8, 2017. The huddle survey was sent to 11 participants and 9 responses were received. Positive impact on Time Goals was: 78% for attending arrival by 8:30 am, 89% for signing overnight studies by 11 am, 89% for hand-off at 4:50 pm, and 79% for concluding service at 5 pm. Positive impact on Resource Availability was: 78% for faculty, fellow and resident leave throughout the day, and 67% for coverage for fetal MRIs. Positive impact on Operational Functionality was: 56% for determine who can protocol CT and MRI studies, check sedated studies, and consult with clinicians. The strengths were "quick, organized, facilitates communications". Improvements were "daily review of the CT and MRI schedule".

CONCLUSION

We are successfully using reading room huddles to communicate our time goals, assure attending and trainee availability, and identify any education needs of trainees. The feedback shows a favorable rating of the reading room huddles, although hard data to check its impact on the performance goals remains to be collected and analyzed. After the initial success, our huddle form is now being adopted at additional reading sites within the adult neuroradiology section.

CLINICAL RELEVANCE/APPLICATION

Reading room huddles are a useful communication tool that can be used to assure that performance metrics, including those related to direct patient care, are effectively communicated on a daily basis.

SSG07

Informatics (Structured Reporting and Workflow)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: N230B

IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Asim F. Choudhri, MD, Memphis, TN (*Moderator*) Nothing to Disclose
Christopher R. Deible, MD, PhD, Allison Park, PA (*Moderator*) Nothing to Disclose
Pamela T. Johnson, MD, Baltimore, MD (*Moderator*) Nothing to Disclose

Sub-Events

SSG07-01 Patient-Centered Radiology Reporting: Utilizing Online Crowdsourcing to Assess the Effectiveness of a Web-Based Interactive Radiology Report

Tuesday, Nov. 28 10:30AM - 10:40AM Room: N230B

Awards
Student Travel Stipend Award

Participants
Ryan G. Short, MD, Durham, NC (*Presenter*) Co-founder, Scanslated, Inc; Officer, Scanslated, Inc
Dana Middleton, BA, Durham, NC (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the effectiveness of a patient-centered web-based interactive mammography report.

METHOD AND MATERIALS

A survey was distributed on Amazon Mechanical Turk, an online crowdsourcing platform. The study population included 193 female U.S. residents ages 18 or older, randomized to one of three simulated BI-RADS 0 mammography reports: (1) web-based interactive report, (2) standard radiology report, or (3) Mammography Quality Standards Act (MQSA)-modelled patient letter. Participants responded to questions pertaining to report comprehension, satisfaction with and perception of the interpreting radiologist, and experience with the presented report. Two-tailed, non-paired t-tests and chi-squared tests were used to evaluate differences in responses between groups.

RESULTS

Report comprehension was significantly higher for the interactive web-based report group compared to the standard report group (1.9 vs. 1.7, $p=0.033$). Satisfaction with the interpreting radiologist was also significantly higher for the web-based interactive report group compared to the standard report group (22.1 vs. 19.7 out of 25, $p<0.001$). Overall, the patient letter group performed better than the standard report on many of the assessed criteria, however there were no significant differences between the patient letter and web-based interactive report groups.

CONCLUSION

This study suggests that radiology reporting style influences the effectiveness of result communication. Our data suggest that a web-based interactive patient report may increase report viewing time, patient comprehension, and satisfaction with the interpreting radiologist compared to the standard radiology report. Future work is needed to determine if these findings are reproducible in actual patient care settings, and to determine how best to use web-based portals for optimal patient-centered radiology communication.

CLINICAL RELEVANCE/APPLICATION

As online patient portals become more prevalent, radiologists must implement novel and effective methods to optimize patient communication, such as our patient-centered interactive report.

SSG07-02 Comparison of TIRADS Scoring Systems Using Consensus Lexicon

Tuesday, Nov. 28 10:40AM - 10:50AM Room: N230B

Awards
Trainee Research Prize - Fellow

Participants
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Aya Kamaya, MD, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare the predictive performance of six previously reported ultrasound (US) based thyroid nodule malignancy scoring systems and identify visual features that are most discriminative.

METHOD AND MATERIALS

After IRB approval, we collected US images of 47 malignant and 46 benign biopsy-confirmed nodules from 93 patients. Using the standardized lexicon for Thyroid Imaging, Reporting and Data System (TIRADS) of the ACR, we identified 20 descriptors reflecting presence or absence of the following visual features: solid, predominantly solid, predominantly cystic, cystic or spongiform composition; hyperechoic, isoechoic, hypoechoic or very hypoechoic echogenicity; taller-than-wide shape; smooth, irregular, lobulated or ill-defined nodule margin, halo, extrathyroidal extension, punctate echogenic foci, macrocalcifications, peripheral calcifications and comet-tail artifacts. Blinded to the diagnosis, an expert radiologist reviewed the images and recorded the features. We then compared six TIRADS scoring systems as described in the works of Park et al., Kwak et al. in 2011, Kwak et al. in 2013, Zayadeen et al., Russ et al., and the ACR TIRADS of 2017.

RESULTS

Malignancy prediction performance of the TIRADS scoring systems in terms of AUC was 0.73 for Park et al., 0.72 for Kwak et al. 2011, 0.81 for Kwak et al. 2013, 0.77 for Zayadeen et al., 0.78 for Russ et al. and 0.73 for ACR TIRADS. Analysis of feature importance, measured as decrease in AUC in its absence, revealed that the most important features were punctate echogenic foci for Russ et al. (0.05), Zayadeen et al. (0.05) and Park et al. (0.08), very hypoechoic echogenicity for Kwak et al. 2013 (0.06) and Kwak et al. (0.03), and macrocalcifications for ACR TIRADS (0.01). Univariate analysis revealed punctate echogenic foci to be the most disctiminative individual feature with AUC of 0.68.

CONCLUSION

The use of descriptors derived from the standardized ACR TIRADS lexicon helped implement six risk stratification systems based on different lexicons. The best performing system, Kwak et al. 2013 with AUC of 0.81, was the only system based on multi-center studies. Presence of echogenic foci and very hypoechoic echogenicity were found to be most important features.

CLINICAL RELEVANCE/APPLICATION

The use of standard descriptors of thyroid nodule appearance enables the use of malignancy scoring and stratification systems, which could ultimately help decrease unnecessary biopsies.

Honored Educators

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SSG07-03 Ontology-Driven Data Mining: Estimating Conditional Probabilities from Unstructured Radiology Reports

Tuesday, Nov. 28 10:50AM - 11:00AM Room: N230B

Participants
Charles E. Kahn JR, MD, MS, Philadelphia, PA (*Presenter*) Nothing to Disclose

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PURPOSE

Conditional probability values -- used in radiology decision support systems -- typically have been provided by experts or computed from discrete data. We sought to develop an automated, ontology-based approach to estimate conditional probabilities from a database of unstructured, narrative-text radiology reports.

METHOD AND MATERIALS

The Radiology Gamuts Ontology (RGO) expresses knowledge of 13,965 diseases and imaging findings, and the 1,682 hierarchical ('is-a') relationships and 55,569 causal relationships between those terms. Using RGO terms and their synonyms, an information-retrieval system performed named-entity recognition and negative-expression filtering to identify positive mentions of RGO entities in all radiology reports generated by a large academic and community health system in 2016. Conditional probabilities were computed based on co-occurrence of entities in the set of patients using expected likelihood estimation (λ=0.5). The feasibility of the approach was tested using two examples of differential diagnosis based on the ontology.

RESULTS

The database contained 942,979 reports on 638,152 distinct patients. Conditional probabilities were estimated for the causes of two index conditions: diffuse bowel wall thickening and splenomegaly. The entities with the greatest conditional probability given the presence of diffuse bowel wall thickening were cirrhosis and hypoproteinemia, with estimated conditional probabilities of 17.5% and 12.8%, respectively. The probability of diffuse bowel wall thickening given the presence of systemic lupus erythematosus (SLE) was estimated as 0.08%; none of the 634 patients with SLE had a report that mentioned diffuse bowel wall thickening. The two most likely causes of splenomegaly were cirrhosis and leukemia, with conditional probabilities of 36.0% and 5.8%, respectvely. A

Bayesian-network model was constructed using the probability estimates.

CONCLUSION

Ontology-driven mining of unstructured radiology reports can compute conditional probabilities for use in decision support systems.

CLINICAL RELEVANCE/APPLICATION

Ontology-based knowledge can guide a case-retrieval system to search radiology reports for terms related to imaging findings and their related causes. The approach can extract quantitative information from conventional narrative ('free-text') radiology reports, which can be used to improve diagnostic decision making in radiology.

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SSG07-04 Recall of Unstructured Radiology Reports is Significantly Inferior to Recall of Structured Reports

Tuesday, Nov. 28 11:00AM - 11:10AM Room: N230B

Participants
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PURPOSE

To measure recall of structured compared to unstructured radiology reports.

METHOD AND MATERIALS

Institutional review board approval was obtained. A structured radiology report is a uniform report template that uses headings and subheadings followed by standardized statements to create uniformity and improve communication with referring physicians. A structured radiology report differs from the "free text" radiology report, which lacks headings or a standardized format. Four hypothetical radiology reports, two structured and two unstructured, were devised based on a review of common cross-sectional imaging studies. The reports, each followed immediately by a multiple-choice questionnaire listing possible diagnoses from the report, were distributed to healthcare professionals using a web-based survey tool, respondents consented to the survey. The diagnoses included in the multiple choices were either present in the radiology reports or were dummy diagnoses. Based on the number of correct responses, correct critical findings and incorrect responses, rates per number of potential diagnoses were calculated for each individual and averaged. The paired sign test compared results between structured and unstructured reports.

RESULTS

148 healthcare professionals completed the survey. The mean percentage of incorrect diagnoses was 4.5% for structured reports compared to 16.7% for unstructured reports ($p<0.001$). The average rate of critical diagnosis recall was 82.7% for structured reports and 65.1% for unstructured reports ($p <0.001$). The average percentage of all diagnoses detected (respondent sensitivity to recall any of the report diagnoses) for structured compared to unstructured reports was 64.3% and 59.0%, respectively ($p = 0.007$).

CONCLUSION

Recall of unstructured radiology reports is significantly inferior to recall of structured reports immediately after reading the report. Structured reports more accurately convey the salient findings of a radiology study.

CLINICAL RELEVANCE/APPLICATION

Structured radiology reporting leads to fewer missed critical findings and better recall of critical findings. Structured radiology reporting is therefore likely to improve patient care through the more efficient transfer of information from the radiologist's report to the referring clinician.

SSG07-05 Flexible and Scalable Radiation Dose Monitoring and Reporting using RadLex Playbook

Tuesday, Nov. 28 11:10AM - 11:20AM Room: N230B

Participants
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CONCLUSION

We demonstrated the ability and utility of the RadLex Playbook to unify diverse names across devices within an institution and to facilitate dose reporting in individual types of imaging procedures as well as groups of procedures. Our work and results should be

applicable to other institutions and types of procedures, and may streamline and improve dose reporting and monitoring.

Background

Monitoring and reporting radiation dose in imaging procedures is challenging due to variation in naming conventions. It is also difficult to create reports that aggregate several types of procedures relevant for dose reporting. Our goal was to adapt and apply the RadLex Playbook standardized nomenclature to unify disparate names of CT imaging procedures to enable dose reporting and summarization of dose data according to clinically relevant groups of procedures.

Evaluation

The RadLex Playbook provides a composable grammar for naming imaging procedures using RadLex atomic terms. We extended Playbook V2.3 to cover specific aspects of CT imaging that are needed for reporting dose information (e.g., pediatric vs. adult subject, age range, and field of view) at our institution. We created Playbook identifiers and corresponding sets of RadLex terms to describe CT imaging procedures at our institution (e.g., Pediatric head (32-cm) 6-15y) and mapped them to the various procedure names collected in our dose reporting system (DoseWatch, GE Medical Systems). We then wrote queries to generate dose reports for 20 different types of CT procedures as well as 7 types of high-level queries that aggregated several types of CT procedures (e.g., average dose for all perfusion head CT procedures).

Discussion

A major challenge for dose reporting is variations in naming procedures across institutions within a single hospital system, and even among imaging devices in a single hospital. By using Playbook and doing a one-time mapping to the disparate names used by the different devices, we could generate dose reports in a facile manner. Moreover, we could easily generate reports that aggregate many different types of imaging procedures, such as determining the average dose of all different kinds of perfusion head CT procedures.

Honored Educators

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SSG07-06 Multicenter Implementation of a Quality Project on MR Protocol and Workflow Optimizations Based On Clinical Indication: Preliminary Results from a Prospective Study

Tuesday, Nov. 28 11:20AM - 11:30AM Room: N230B

Participants
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PURPOSE

In clinical routine, MRI protocols are not often harmonized across scanners with consequent large variation in exam duration and inefficient machine utilization. The aim of this study was to harmonize and optimize MRI protocols thanks to data analytics.

METHOD AND MATERIALS

Data from a multicenter setting comprising 4 hospitals and 5 MR scanners (four 1.5 T, one 3T, GE Healthcare) were collected through a software. A core-team was set-up (one radiologist and one referring technologist, MR application specialist). A comprehensive four-steps strategy was implemented: 1) MPPS and DICOM headers data collections on a central server; 2) data analyses through an ETL (Extract Transform Load, Talend) module and a business-intelligence software (Centricity Insights, GE Healthcare); 3) protocol and workflow optimization; 4) assessment modification on practices. In the data analyses phase, focus was set on 3 scanners (two 1.5T and one 3T) and 3 protocols per scanner (knee, shoulder, cervical spine CS, lumbar spine LS depending on the scanner). In the optimization phase, tweak of scan time, matrix size, number of excitation, acceleration factor and field of view were implemented to harmonize the total sequence duration if possible. Image quality was also assessed.

RESULTS

About 3300 exams were collected. We identified strong variations in scan duration between scanners for the 4 most practiced procedures (Knee, Shoulder, LS, CS). As an example, for shoulder we identified a variation of 4 min between 2 systems (from 12 min to 16 min). In that case, sequence Cor PD FS FSE showed a difference of 1:12min (3:02min vs 4:14min) which was reduced to 4 seconds between machines (3:02min vs 3:06min) by harmonizing acceleration factors and matrix size. Generalizing this approach to all sequences of shoulder protocol allowed to reduce the exam duration by 13%. Generalizing to most performed procedure and optimizing the scheduling allowed an increase of 20 exams/week (14% of total activity). Preliminary results on image quality confirmed diagnostic level.

CONCLUSION

By implementing automatic collection of operational and clinical data in MR we could standardize and harmonize protocols to guarantee uniform diagnostic image quality while increasing productivity and patient satisfaction.

CLINICAL RELEVANCE/APPLICATION

Harmonizing and optimizing MR protocols as well as scheduling implies quality in healthcare and increased productivity.

SSG07-07 Light-Messenger: A Web-Based, Gamification Enhanced Notification System to Replace Intra-

Department Phone Calls with Light Signals in a CT and MRI Protocolling Workflow

Tuesday, Nov. 28 11:30AM - 11:40AM Room: N230B

Participants
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PURPOSE

To reduce frequent intra-departmental phone calls in a digital protocolling workflow during radiology scheduling. Scheduling CT/MRI technologist frequently call each subspecialty section (40-60 calls/day) as a reminder to protocol urgent or non-urgent requests in order to complete scheduling of in- and outpatients.

METHOD AND MATERIALS

A web-based platform was conceived to substitute phone calls with a light signal in each reading room through a "sender" web page offering 3 buttons for each subspecialty to broadcast "please protocol" with different color-coded priorities: low (green) = non-urgent protocol; medium (orange): protocol in the next 15 minutes; high (red) = protocol immediately. A java-based server application (Java EE) addresses microcontrollers (Arduino YUN) in each reading room which control LED strips. The radiologists confirm on a "receiver" website that they a) perceived the signal and b) will protocol. A gamification system with high score ranking was implemented adding achievements such as "first confirmation of the day", "fastest confirmation time", "most confirmations a day" et cetera. Prior and post introduction of the "light messenger" an online survey was conducted to assess satisfaction with the protocolling process and identify reasons for discontent. Furthermore, RIS timestamps from order entry and protocolling performed events were gathered to analyze the duration of the protocolling process.

RESULTS

Since the introduction in 8/2016 duration from order entry to protocolling was reduced by 28% for the median (36 to 26 min.); 31% for the upper (171 to 118 min.) and 11% for the lower quartile (9 to 8 min.). Satisfaction with the scheduling process increased for all teams especially the CT team. In the survey "frequent queries necessary" was listed 42% less as a primary reason for discontent, "frequent phone calls" 27% less and the "protocolling duration" 38% less. On average 40 phone calls/day were replaced with non-disruptive light signals.

CONCLUSION

A formerly disruptive workflow was transformed into a less disruptive process with increased satisfaction across teams, more time for core activities and shortening of scheduling duration.

CLINICAL RELEVANCE/APPLICATION

More time for core activities and less disruption ultimately translates into better patient care by faster scheduling and more time to focus on image acquisition and reading.

SSG07-08 Toward Interoperability of Image Annotations: Automated Conversion of Image Annotations in PACS to the Annotation and Image Markup Format

Tuesday, Nov. 28 11:40AM - 11:50AM Room: N230B

Participants
Nathaniel Swinburne, MD, New York, NY (*Presenter*) Nothing to Disclose
Hakan Bulu, Istanbul, Turkey (*Abstract Co-Author*) Nothing to Disclose
Sara Lewis, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
David S. Mendelson, MD, Larchmont, NY (*Abstract Co-Author*) Spouse, Employee, Novartis AG Advisory Board, Nuance Communications, Inc Advisory Board, General Electric Company Advisory Board, Toshiba Medical Systems Corporation Advisory Board, Bayer AG
Daniel L. Rubin, MD, MS, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose

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CONCLUSION

As quantitative imaging becomes more prevalent in radiology, interoperability of image annotations gains increasing importance. Our work provides a mechanism to expose this data and enable easy exchange and incorporation with other structured and quantitative data in the patient's longitudinal medical record. This first step along with the harmonization of AIM with DICOM-SR could ultimately improve patient care in multiple use cases including treatment response evaluation.

Background

Sharing radiologic image annotations among multiple institutions is important in many clinical scenarios such as tracking cancer

lesions; however, interoperability is thwarted because different vendors' PACS store image annotations in non-standardized, proprietary formats. Interoperability of image annotations is also crucial for data sharing efforts such as the RSNA Image Share initiative. Our goal was to develop software to automate conversion of image annotations in a commercial PACS to the Annotation and Image Markup (AIM) standardized format.

Evaluation

Utilizing the Pixelmed library of DICOM tools and AIM application programming interface (API), we created a software module in Java to parse the DICOM presentation state (DPS) objects (which contain the image annotations) for an imaging study exported from a commercial PACS (GE Centricity v3.x). Our software identifies line annotations encoded within the DPS objects and exports the annotations in the AIM format. To validate the interoperability of our approach, we used our software to import annotations from Centricity PACS into ePAD (http://epad.stanford.edu), a freely available AIM-compliant workstation, and the line annotations were correctly displayed as overlays on the appropriate DICOM images.

Discussion

Our work demonstrates that proprietary format DICOM image annotation data can be automatically converted to a standardized format such as AIM, enabling interoperability and use by vendor-neutral applications. This effort could be extended for use with other vendors' PACS.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Daniel L. Rubin, MD, MS - 2012 Honored EducatorDaniel L. Rubin, MD, MS - 2013 Honored Educator

SSG07-09 Readability of Radiology Reports

Tuesday, Nov. 28 11:50AM - 12:00PM Room: N230B

Awards
Student Travel Stipend Award

Participants
Teresa Martin-Carreras, MD , Philadelphia, PA (*Presenter*) Nothing to Disclose
Charles E. Kahn JR, MD, MS, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

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CONCLUSION

Radiology reports often contain complex sentences, polysyllabic terms, and concepts that may be unfamiliar to those outside of radiology. As increasing numbers of patients read radiology reports, the reports' high reading levels may present challenges to their understanding. The average U.S. adult reads at an 8th grade reading level, and fewer than 4% of all radiology reports in our sample were readable at or below this level. While the target audience of radiology reports has traditionally been the referring provider, the ready access to online medical records requires that radiologists consider the impact of their reports on the patient, and emphasizes the need for the expansion of lay-language resources which may facilitate patient understanding of their radiology reports.

Background

Although originally written primarily for referring healthcare providers, radiology reports are increasingly read by patients as health systems institute electronic health portals for patients to access their medical records. This report sought to assess the readability of radiology reports.

Evaluation

Radiology reports from January 1, 2017 to February 3, 2017 from a large health system were randomly sampled and reviewed retrospectively. The number of words and sentences in each report was computed. Three readability indices were measured: Flesch-Kincaid Grade Level (FKGL), Gunning Fog index (GFOG), and Simple Measure of Gobbledygook (SMOG). A "reading grade level" was computed as the mean of the three indices for each report. Mean and standard deviation (SD) were computed for the reports' sentence count, word count, and readability indices. Pairwise correlation between readability indices was measured. This HIPAA-compliant study was approved by the organization's Institutional Review Board; informed consent was waived.

Discussion

Of the 108,228 reports sampled, 2,947 duplicate reports were excluded. The 105,281 included reports contained a mean (± SD) of 17.8 ± 13.1 sentences and 205 ± 161 words. The mean reading grade level was 12.9 ± 2.4. There were 4,094 reports (3.9%) at reading grade level <= 8, of which 650 reports (0.6%) were at reading grade level <= 6.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Charles E. Kahn JR, MD, MS - 2012 Honored Educator

SSG08

Molecular Imaging (Oncology)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S504CD

BQ MI NM OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Zaver M. Bhujwalla, PhD, Baltimore, MD (*Moderator*) Nothing to Disclose
Gabriel C. Fine, MD, Seattle, WA (*Moderator*) Nothing to Disclose

Sub-Events

SSG08-01 Detection of Metabolic Subgroups in DEN-Induced HCC Using Hyperpolarized 13-C-Pyruvate-MRSI

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S504CD

Awards
Student Travel Stipend Award

Participants
Georgios Kaissis, MD, PhD, Munchen, Germany (*Presenter*) Nothing to Disclose
Elisabeth Bliemsrieder, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Fabian Lohoefer, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Hepatocellular carcinoma (HCC) is characterized by genetic, structural and metabolic heterogeneity. Since tumor metabolism is a possible target for oncological pharmacotherapy, non-invasive methods for subgroup detection and stratification are needed. Notably, differentiation of highly glycolytic tumors from those with lower glycolytic capacity is a promising target for stratification and therapy. The aim of this study is to evaluate magnetic resonance spectroscopic imaging (MRSI) using hyperpolarized 13-C-Pyruvate as an imaging modality for non-invasive detection of metabolic tumor heterogeneity in diethyl nitrosamine (DEN)-induced HCC in rats.

METHOD AND MATERIALS

A total of 21 tumor bearing and 5 control animals were imaged using free-induction-decay chemical-shift imaging (FID-CSI). Signal intensity ratios between Lactate and Alanine (Lac/Ala-Ratios) were calculated based on label exchange between hyperpolarized metabolites. Tumors were removed and subjected to histopathology and immunostaining. In addition, rtPCR of tumor extracts was performed and LDH and GPT activities measured in tumor extracts using liquid NMR spectroscopy.

RESULTS

Lac/Ala-Ratio was significantly higher in HCC precursor lesions and in HCC than in normal liver (p=0.0007). LDH/GPT ratios in tumor extracts correlated positively with Lac/Ala-Ratios (R2=0.357). rtPCR of tumor extracts yielded increasing expression levels of glycolytic enzymes and increasing expression of EpCAM with increasing Lac/Ala ratios.

CONCLUSION

MRSI with hyperpolarized metabolites can reliably differentiate between normal liver and HCC and is able to discern highly glycolytic tumors, offering a non-invasive approach for tumor stratification and a potential readout for non-invasive monitoring of antiglycolytic pharmacotherapy in HCC.

CLINICAL RELEVANCE/APPLICATION

This preclinical study demonstrates the usage of hyperpolarized MRSI for metabolic tumor subgroup detection in HCC. This method can aid future translational and personalized medicine approaches in pre-therapy risk stratification by allowing non-invasive and radiation-free characterization of tumor biology.

SSG08-02 Comparison of 68Ga-PSMA PET/CT with Multiparametric MRI for Staging High Risk Prostate Cancer

Tuesday, Nov. 28 10:40AM - 10:50AM Room: S504CD

Participants
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PURPOSE

To compare Ga-68 PSMA PET/CT with MPMRI for the staging of high risk prostate cancer.

METHOD AND MATERIALS

This was a prospective study in which 36 patients with high-risk prostate cancer with a serum PSA >=20 and/or Gleason's Score >=8. Each patient then underwent both Ga-68 PSMA PET/CT and MPMRI including DWIBS within an interval of one week. For comparison, the prostate gland was divided into twelve segments, the segment with the highest SUVmax and lowest ADC value was localized as the probable primary site. If this segment corresponded on PET/CT and MRI it was taken as concordance and if abnormal tracer accumulation was seen to extend into either seminal vesicle it was taken as involvement on PET. Lymph node and skeletal involvement was evaluated on a per patient basis and regional basis. Each patient was staged using TNM classification on both modalities and compared.

RESULTS

Median age of 36 patients included was 65years and median PSA was 94.3 ng/ml. Concordance for localization of primary on Ga-68 PSMA PET/CT & MRI was seen in 19/36 36 patients (52.7 %). PET was incorrect for seminal vesicle involvement in 8 patients. Capsular involvement could not be commented upon on PET. T staging on Ga-68 PSMA and MRI was similar in 21/36 patients (58.3 %) and differed in 15/36 patients (41.7 %). Ga-68 PSMA PET/CT detected higher number of patients with regional (44) lymph nodes in comparison to MRI (25). Concordance for regional lymph node staging was seen in 25 patients (69.4 %) and for non-regional lymph node staging in 26 patients (72.2 %). In one patient PET/CT reported skeletal metastases which was not seen on MRI. Ga-68 PSMA PET/CT detected distant metastases involving lung (2 patients) and liver (1 patient) not seen on MRI. In comparison to MRI. Ga-68 PSMA PET/CT changed M stage from M0 to M1a in one patient, from M0 to M1b in 1 patient and from M1b to M1c in 3 patients.

CONCLUSION

In comparison to MRI Ga-68 PSMA PET/CT was able to detect more lymph node (both regional and non-regional) involvement as well as metastases. It was also useful for localization of primary cancer. However concordance for primary localization by Ga-68 PSMA PET/CT was limited and so was the depiction of capsular invasion and seminal vesicle involvement.

CLINICAL RELEVANCE/APPLICATION

Ga-68 PSMA PET/CT is useful for lymph node and metastases staging in high-risk prostate cancers and presently its utility for staging of disease in the prostate is limited.

SSG08-03 HER2-Positive Tumor Accumulation of Conventional Heterogenous versus Novel Site-Specific Ga-67 Radiolabeled Anti-HER2 Antibody

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S504CD

Participants
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Kaoru Maruyama, Hirakatashi, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare the accumulation of Ga-67 labeled anti-HER2 antibodies with novel homogeneous site-specific conjugation versus conventional chemical, heterogeneous site, conjugation in HER2-positive tumors.

METHOD AND MATERIALS

First, anti-HER2 antibody was chemically conjugated with deferoxamine. The resulting chemical conjugate was radiolabeled with Ga-67 (Chem-Ab). Second, site-specific anti-HER2 antibody conjugation was performed with 67-Ga radiolabeled transglutaminase (SSC-Ab). In vitro, binding activity of HER2 to both antibodies, Chem-Ab and SSC-Ab, was evaluated using ELISA with fluorescent antigen labeling. In vivo, a xenograft mouse model consisting of subcutaneously transplanted CHO cells with HER2 overexpression was established. We divided the subjects into the Chem-Ab group (n=7) and the SSC-Ab group (n=7). Planar images were acquired over three days, for both groups, after antibody injection and the tumor / whole body count ratios (T/WB ratio) was measured. On the fourth day, pharmokinetic analysis was used to compare the Chem-Ab group to the SSC-Ab group, in both whole organs and tumor, for Ga-67 accumulation of.

RESULTS

SSC-Ab was found to have a higher binding capacity than Chem-Ab. The T/WB ratio increased in both groups. On the third day, the SSC-Ab group had a significantly higher T/WB ratio than the Chem-Ab group (p=0.03). In the SSC-Ab group, the antibody

accumulation was significantly higher than the Chem-Ab group in not only the tumors (20.37, 15.08 %ID/g, p=0.016), but also in the liver and spleen.

CONCLUSION

The site-specific conjugation method enhanced the accumulation of the anti-HER2 antibody labeled with Ga-67 in tumors and also in in the liver and spleen as well.

CLINICAL RELEVANCE/APPLICATION

Novel homogeneous site-specific antibody conjugation with Ga67 may offer improved efficacy in solid tumour radioimmunotherapy over conventional heterogeneous conjugation.

SSG08-04 Improved Oncological 18F-FDG PET Imaging Using Concurrent Octreotide Acetate Administration to Suppress Brown Fat and Cardiac Uptake

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S504CD

Awards
Student Travel Stipend Award

Participants
Pedram Heidari, MD, Boston, MA (*Presenter*) Nothing to Disclose
Peiman Habibollahi, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Umar Mahmood, MD,PhD, Charlestown, MA (*Abstract Co-Author*) Co-Founder, CytoSite Biopharma; Stockholder, CytoSite Biopharma; Consultant, CytoSite Biopharma

PURPOSE

This study evaluates the effect of octreotide acetate (OCT) in improving the FDG biodistribution for oncological imaging, with assessment of the likely mechanism of action.

METHOD AND MATERIALS

To demonstrate a somatostatin receptor (SSTR)-independent effect, AR42J (high), HT-29 (low) and A549 (negligible SSTR) cell lines were incubated with FDG and OCT at 10-11 to 10-6 M concentration and were counted for tracer retention. Temporal serum insulin (INS) level was measured using ELISA in mice that received an IP dose of vehicle or OCT (0.6-5 mg/kg). HT-29 bearing mice were fasted for 4h and treated with an IP injection of saline (control), OCT (5mg/kg), or OCT+INS (Novolin 5 IU/kg) 20 minutes before FDG injection and were subsequently imaged using PET or sacrificed to measure FDG organ biodistribution. Cytosolic and plasma membrane (PM) Glut-4 expression were measured using Western blot of tumor, muscle, brown fat and heart in all groups.

RESULTS

There was no significant difference in FDG uptake of HT-29, A549 or AR42J cells treated with different doses of OCT. There was a significant dose-dependent reduction in the serum INS in mice treated with OCT which peaked at 15-30 minutes. A significant reduction in SUVmean of cardiac muscle and brown fat was seen in OCT compared to control group, while the tumor uptake was similar between 2 groups. The OCT+INS group had intense uptake in cardiac muscle and brown fat and reduced uptake in the tumor. FDG uptake in the biodistribution studies paralleled those of PET. We note a decline in the Glut-4 PM fraction in heart and skeletal muscle, brown fat, and tumor in the OCT group compared to control and OCT+INS groups. The cytosolic fraction of Glut-4 increased in the OCT group.

CONCLUSION

OCT can improve the FDG biodistribution for oncological imaging, resulting in minimal change in tumor uptake, and reduced brown fat and cardiac uptake. The mechanism likely involves reduction of serum INS and decrease of Glut-4 PM fraction. The tumor uptake is not affected as it is usually mediated via highly expressed Glut-1 and 3.

CLINICAL RELEVANCE/APPLICATION

Brown fat and cardiac uptake pose diagnostic challenges in oncological FDG PET imaging. Octreotide injection could offer an alternative to strict and cumbersome protocols for reduction of brown fat and cardiac uptake without a significant effect on tumor FDG uptake.

SSG08-05 Orthotopic Hepatic Cancers: Optical Imaging-Monitored Intratumoral Radiofrequency Hyperthermia-Enhanced Direct Oncolytic Virotherapy

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S504CD

Participants
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PURPOSE

To investigate the feasibility of using molecular imaging-guided intratumoral radiofrequency hyperthermia (RFH) to enhance the direct oncolytic virotherapy of orthotopic hepatocellular carcinoma (HCC) in rats.

METHOD AND MATERIALS

This study included in-vitro confirmation experiments using luciferase-labeled rat hepatic cancer cells (McA-RH 7777) and in-vivo validation experiments on orthotopic hepatic cancers in nude rats. Both cells and hepatic cancers in four groups (n=6/group) were treated by: (i) combination therapy with intratumoral oncolytic virotherapy (T-VEC) plus RFH at 42 ? for 30 minutes; (ii) T-VEC alone; (iii) RFH alone; (iv) phosphate buffered saline (PBS). For in-vitro confirmation, confocal microscopy and bioluminescence optical imaging of cells in agarose were used to evaluate the cell viabilities and apoptosis. For in-vivo validation, T-VEC were directly infused into the margins of hepatic cancers through the injection needles of a multipolar RF probe, followed by RF hyperthermia at 42 ? for 30 minutes. Optical imaging and ultrasound imaging were used to follow up bioluminescence signal and size changes of tumors over two weeks, which were correlated with subsequent histology analysis.

RESULTS

Of in-vitro experiments, confocal microscopy showed the lowest number of viable cells, as well as a significant decrease of bioluminescence signal intensity of cells in combination therapy group, compared to the other three control groups ($P < .001$). Of in vivo experiments, optical imaging demonstrated significantly decreased bioluminescence signal intensity in combination therapy group, compared with the other three treatment groups ($P < .05$). Ultrasound images showed the smallest tumor volumes of the combination therapy group, in comparison to the other three treatment groups ($P < .05$). Imaging findings were well correlated with the increased apoptosis in the combination therapy group, compared to other three control groups (Figure).

CONCLUSION

We have validated the feasibility of using intratumoral RFH to enhance oncolytic virotherapy of HCC, which is effectively monitored by optical imaging and ultrasound imaging techniques. This new concept may open new avenues for eradicating the residual tumor at the margins of RF ablated HCCs.

CLINICAL RELEVANCE/APPLICATION

This study may open new avenues for eradicating the residual tumor at the margins of RF ablated HCCs.

SSG08-06 NaLuF4 for Spectral CT in the Diagnosis of Osteoscarcoma

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S504CD

Participants
Yingying Jin, PhD, Shanghai, China (*Presenter*) Nothing to Disclose
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Lu Gao, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Fang Han, MBBS, MS, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Yi Lv, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Zhenwei Yao, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
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Wenbo Bu, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Jiawen Zhang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To investigate the potential of spectral computed tomography (CT), used in combination with a Lutecium-based upconversion nanoparticles (UCNPs), for characterization of osteosarcoma and bone.

METHOD AND MATERIALS

Spectral CT which can enrich conventional CT images with the capability to image and quantify certain elements based on their distinctive Kedge energies was chosen as a powerful tool. Lutecium-based upconversion nanoparticle (UCNPs) had higher spectral CT performance compared with clinically used iohexol. Spectral CT performance was investigated by testing gradient concentration of these contrast agents (CAs) in vitro. Balb/c nude mice were used as model for imaging osteosarcoma in vivo. Cellular uptake of Lutecium-based UCNPs was further evaluated by using confocal microscopy. Toxicity tests were also carried out including cellular toxicity tests, blood routine examinations, hepatorenal function, body weight and some other indexes.

RESULTS

Spectral CT enabled differentiation of Lutecium-based UCNPs, iohexol and bone. Different materials were presented as colorized voxels against the normal grayscale X-ray background, distinguishing the high attenuation of calcium from the osteosarcoma tumor tissues that contained the Lutecium-based CAs. The results of in vivo and in vitro experiments demonstrated that Lutecium-based CAs had higher spectral CT performance and could still be obviously observed at higher KeV (120-140 KeV) images while the signals of iohexol and bone were relatively weak. The toxicity was proven to be low which made it potential for clinical application in the future.

CONCLUSION

Spectral CT imaging, combined with Lutecium-based CAs, provided a promising opportunity for effectively distinguishing bone and osteosarcoma in vivo.

CLINICAL RELEVANCE/APPLICATION

Achieving high-resolution imaging of osteosarcoma and in vivo differentiate it from the bone for accurate tumor diagnosis and therapy.

SSG08-07 Dedicated Breast PET (dbPET) for Quantifies Response to Neoadjuvant Therapy in Breast Cancer: The Irruption of a Great Ally

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S504CD

Participants
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Ines Dominguez, Santiago de Compostela, Spain (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Continued progress in the control of breast cancer will require sustained and increased efforts to provide high-quality screening, diagnosis, and treatment. Recently, the MAMmography with Molecular Imaging (MAMMI) dedicated breast PET (dbPET) has emerged as an additional imaging tool for breast cancer diagnosis, clarification of complex lesions and therapy follow-up. This study is aimed to determine whether correlations exist between physiological images with 18FDG of pre, post-2-cycles and post Neoadjuvant Chemotherapy, with a predictive value of response.

METHOD AND MATERIALS

Two hundred (200) patients, and three scan points: pre, after 2 cycle and post (pre-surgery) Neoadjuvant Chemotherapy were included in this study. A prone position high-resolution dedicated breast PET (MAMMI-dbPET) was performed 60 min after administration of 120-140 MBq of 18F-FDG. Maximum standardized uptake value (SUVmax) quantification, volume characterization, positioning in all three space-axes, distances to reference points (proximal breast limit, nipple areola complex) were registered.

RESULTS

When treatment was successful, a significant difference was found between pre and post neoadyuvant chemotherapy status and the SUVmax ($p < 0.001$) of breast tumors. Pre Neoadjuvant (mean SUVmax, 13.1) demonstrated a significantly higher SUVmax than did post 2 cycles tumors (median SUV, 5.5) ($p= 0.019$). No statistical significant difference was found for SUVmax of post-2 cycles vs. post lesions with a mean SUVmax of 5.5 and 3.9 ($p=0.35$) respectively. A statistically significant difference was found for volume measurement of pre vs. post-2 cycles vs post Neoadjuvant therapy lesions. A clear qualitative difference by three different observers has been reported among dbPET and MRI volume characterization.

CONCLUSION

dbPET MAMMI has proven to be an excellent tool for quantification, 3D spatial localization and monitoring of neoadjuvant therapy. Our data suggest that SUVmax measurements of 18FDG-dedicated breast PET can provide valuable information about therapy efficiency. Such an association might be of relevant importance to treatment continuity or adjustement.

CLINICAL RELEVANCE/APPLICATION

The use of a physiological technique such as dbPET, will allow us to be more precise and in an earlier way in the follow-up of the treatment.

SSG08-08 Enhancing Tumor MRI with a CA IX-Targeted Dendritic Contrast Agent

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S504CD

Participants
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Jianbin Tang, Hangzhou, China (*Abstract Co-Author*) Nothing to Disclose
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Hongjie Hu, MD, Hangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Youqing Shen, Hangzhou, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

A novel dendritic contrast agent (DCA) based on an internal functional dendrimer with CA IX-targeted groups (sulfonamide) on surface was prepared to enhance MRI of tumor.

METHOD AND MATERIALS

(1) 4T1 cells (3*105 per well) were cultured in 6-well plate under 5% CO2, 1% O2 and 94% N2 for 48h. Then RhB labeled G3(DTPA-Gd)-SA (CA IX-targeted DCA) and G3(DTPA-Gd)-Cys (Control) was added at 6h. The cells were then collected and measured by flow cytometry (FCM). (2) 4T1 cells was planted in the mammary fat pad of Balb/c mice 6-weeks 5*105 each). After 7 days, two kinds of DCA were injected intravenously and T1-weighted imaging was measured pre-injection and 5 min, 30 min, 60 min, 120 min, 240 min post-injection.

RESULTS

The R1s of G3(DTPA-Gd)-SA and G3(DTPA)-Cys were both slightly over 10 mM-1s-1. It was reported that the CA IX level of 4T1 cell line was induced to higher expression after cultured under hypoxia condition. The results of FCM indicated that the G3(DTPA-Gd)-SA-RhB had significantly higher uptake in hypoxic cells than G3(DTPA-Gd)-Cys-RhB, which provided a brief proof of the capability of sulfonamide based DCA binding to hypoxic 4T1 cell. Moreover, in the in vivo MRI experiment, the signal intensity in the tumor sites for the two groups was similar in the first 2h. However, after 4h post-injection, the tumor area of G3(DTPA-Gd)-SA was still obviously enhanced while that with G3(DTPA-Gd)-Cys already faded.

CONCLUSION

The CA IX-targeted DCA had high cellular uptake in hypoxic cells, and it could enhanced the MRI of tumor. Along with its stable defined structure, CA IX-targeted DCA had great potential in early hypoxic tumor detection.

CLINICAL RELEVANCE/APPLICATION

Early hypoxic tumor detection is a great challenge in clinic. The work provided a hypoxic tumor targeting MRI contrast agent which could increase the accuracy of early hypoxic tumor. Thus, it had great potential for clinical translation.

SSG08-09 Quantitative Granzyme B PET Imaging Predicts Response to Immunotherapy

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S504CD

Awards
Trainee Research Prize - Fellow

Participants
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PURPOSE

Although cancer immunotherapy has delivered stunning responses, these occur in only a small fraction of patients. A predictive biomarker of early response could identify patients for whom therapy is ineffective, allowing alternative treatment based on individualized biological feedback. Granzyme B is released by immune cells during the cellular immune response, and represents one of the dominant mechanisms by which T cells mediate cancer cell death.

METHOD AND MATERIALS

Two mouse tumor models (CT26 and MC38) were used for both biomarker analysis and murine imaging. Mice were treated with either anti-PD-1 mono agent or in combination with anti-CTLA-4, and PET images were acquired prior to growth divergence between treated responders and non-responders. Immunoflourescent and immunohistochemical microscopy was used to quantify total granzyme B in melanomas from 9 patients treated with mono-agent PD-1 therapy.

RESULTS

A novel Granzyme B PET imaging agent was designed and shown to accumulate at significantly higher levels in combination treated and PD-1 treated mice than in vehicle-only mice. Furthermore, imaging of treated mice distinguished two groups with either high or low granzyme B PET tumor uptake. Although on the day of imaging both groups had equivalent tumor volumes, those mice with high PET uptake subsequently regressed, whereas the low PET uptake group uniformly progressed. A retrospective analysis of human melanoma samples revealed similar results, with significantly higher levels of granzyme B found in treated responding patients as early as 15 days post therapy initiation.

CONCLUSION

Two murine models of cancer immunotherapy demonstrate that granzyme B PET imaging is able to distinguish treated responders from non-responders, prior to growth divergence. Additionally, human samples analyzed by our peptide revealed significant differences in accumulation as early as 15 days post-therapy initiation. These results indicate granzyme B imaging is a highly accurate, predictive PET biomarker for immunotherapy response.

CLINICAL RELEVANCE/APPLICATION

A biomarker of early response to cancer immunotherapy is needed. Granzyme B PET imaging represents a novel and accurate approach to quantifying immune response with significant clinical potential.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSG09

Science Session with Keynote: Musculoskeletal (Machine Learning)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: E450B

CT MK MR IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Martin Torriani, MD, Boston, MA (*Moderator*) Nothing to Disclose
Christian W. Pfirrmann, MD, MBA, Forch, Switzerland (*Moderator*) Nothing to Disclose

Sub-Events

SSG09-01 Musculoskeletal Keynote Speaker: Machine Learning Basics: A Radiologist's Perspective

Tuesday, Nov. 28 10:30AM - 10:50AM Room: E450B

Participants
Martin Torriani, MD, Boston, MA (*Presenter*) Nothing to Disclose

SSG09-03 Accelerated Knee MRI with Machine Learning Based Reconstruction Compared to Standard Knee MRI Protocol: Analysis of Protocol Interchangeability and Image Quality

Tuesday, Nov. 28 10:50AM - 11:00AM Room: E450B

Participants
Elisabeth R. Garwood, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

Assess protocol interchangeability and image quality of an accelerated knee MRI reconstructed with a machine learning based algorithm compared to standard MRI.

METHOD AND MATERIALS

A neural network trained to differentiate between acceleration related aliasing artifacts and true image content was developed, according to methods previously described. 25 patients referred for diagnostic knee MRI underwent examination at 3T with five 2D FSE sequences using both standard reconstruction (parallel imaging acceleration factor 2, acquisition time 12:57 minutes) and an accelerated knee protocol that utilized machine learning based reconstruction (acceleration factor 3, 9:10 minutes). Images were interpreted retrospectively by two MSK radiologists, blinded to acquisition and reconstruction parameters, for meniscus, ligament, bone marrow, and chondral pathology. Concordance of standard MRI interpretation was compared to concordance between machine-learning and standard MRI interpretation. Image quality was assessed using a 4-point ordinal scale.

RESULTS

Agreement between readers was similar when using the standard protocol compared to using different protocols (86%-98% for all structures). Different readers had a higher impact on concordance than different protocols, with higher inter-protocol concordance (same reader, different protocols; 93%-99.5%) than intra-protocol concordance (different readers, same protocol; 86%-98%). Interchangeability analysis demonstrated that switching from the standard protocol to machine learning would introduce less than 5% discordance (upper limit of a 95% confidence interval) for all structures. Overall image quality degradation ($p<0.001$) was observed with the machine learning based reconstruction.

CONCLUSION

Accelerated knee MRI utilizing a machine-learning-based reconstruction algorithm was interchangeable with standard knee MRI in terms of diagnostic concordance. However, reduced subjective image quality was observed. Future directions include modification of the loss function that is used during the neural network training procedure and alternative network architectures to improve image quality.

CLINICAL RELEVANCE/APPLICATION

Machine learning based MRI reconstruction promises novel possibilities for scan acceleration. Our initial experience applying this technique to knee MRI demonstrates protocol interchangeability but reduced subjective image quality.

SSG09-04 Automatic Vertebrae Localization and Identification in Spine CT Using Decision Forests

Tuesday, Nov. 28 11:00AM - 11:10AM Room: E450B

Participants
Ana Jimenez-Pastor, Valencia, Spain (*Presenter*) Nothing to Disclose
Angel Alberich-Bayarri, MD, Valencia, Spain (*Abstract Co-Author*) Nothing to Disclose
Belen Fos-Guarinos, Valencia, Spain (*Abstract Co-Author*) Nothing to Disclose
David Garcia-Juan, Valencia, Spain (*Abstract Co-Author*) Nothing to Disclose
Fabio Garcia-Castro, Valencia, Spain (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

In clinical diagnosis and appropriate surgical planning in the spine, the fast recognition and characterization of vertebral bodies is a crucial step. Usually for radiologists it is a time consuming task that hinders the workflow, because they have to label them manually. For this reason, the main purpose of our work was to locate and identify vertebral bodies automatically in body CT scans by applying an Artificial Intelligence (AI) technique.

METHOD AND MATERIALS

A dataset of 200 CT scans with arbitrary field of view were collected. Due to the goal of the study, a wide range of pathological conditions was needed in order to enrich the algorithm. For the automatic localization and identification of vertebral bodies we used Decision Forests, an AI technique based on supervised learning. This means that we need both input and output data to train the forest. An in-house software application was used for labelling the scans by selecting the centroids of each vertebral body included. From the 200 scans 150 were used for training and 50 for test. From each training scan we randomly selected 50.000 voxels. Around each voxel a 3D cuboid was processed, where 126 intensity-based features were extracted as input data. The corresponding output data is the distance from the selected voxels to each vertebra. To test, 100.000 voxels were randomly selected from a previously unseen CT and features were extracted. Using our trained forest, we obtained the predicted distance from each voxel selected to each vertebra. Finally, using this information we could predict their position.

RESULTS

The algorithm was tested against 50 new cases obtaining a satifactory vertebrae classification with no human interaction. A mean performance of 95% for correct localization was achieved. The mean error distance between the real position of vertebrae and the tested one was of 10.5 mm on the thoracic region and of 15.4 mm on the lumbar one.

CONCLUSION

Automatic localization and identification of vertebral bodies can be addressed with excellent results by AI methods to improve diagnosis workflow and characterize bone structure. These methods can be used to address current barriers such as the automatic localization and segmentation of anatomical structures.

CLINICAL RELEVANCE/APPLICATION

Automatic localization and identification of vertebral bodies can help radiologists to perform diagnosis and bone characterization in a shorter period of time.

SSG09-05 Semantic Labeling of Musculoskeletal Radiographs Using Deep Learning

Tuesday, Nov. 28 11:10AM - 11:20AM Room: E450B

Awards
Student Travel Stipend Award

Participants
Stephen R. Vossler, MD, Stanford, CA (*Presenter*) Nothing to Disclose
Imon Banerjee, PhD, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Bao H. Do, MD, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
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Christopher F. Beaulieu, MD, PhD, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Deep convolutional neural networks (CNNs) are rapidly advancing techniques in computer vision that allow rapid, unsupervised feature learning and have potential clinical advantages including speed and consistency. Our goal is to develop and validate a deep CNN system to automatically learn and recognize common musculoskeletal radiographs.

METHOD AND MATERIALS

793 radiographs of major appendicular joints were exported and anonymized from PACS. Images were annotated with 13 class labels: AP and lateral views of the ankle, elbow, foot, hand, and knee, AP views of the pelvis, and AP and axillary views of the shoulder. To create a normalized dataset for training, we implemented an image preprocessing step that adjusts window/level settings based on image bit depth and sharpens the image by enhancing low contrast local image regions. We adapted a transfer learning approach and fine-tuned the weights of ImageNet's pre-trained AlexNet CNN to recognize 13 classes by continuing the backpropagation. For training and validation, we used a hold-out approach (793 training images, 154 validation images). The deep CNN was trained using Matconvnet on a 2.3GHz Intel Core i7 with 8GB of RAM and an NVIDIA GeForce GT 650M 285. Training parameters: Momentum 0.9, Weight decay 3e-4, Epoch size 50, and batch size 50. Performance accuracy was measured as percentage of correctly labeled class, and the top-5 error rate was the fraction for which the correct label was not among the five labels.

RESULTS

The deep CNN performed with an accuracy of 97.4% on the test dataset. The top-5 error rate was 0%.

CONCLUSION

We have implemented a deep CNN that automatically classifies radiographs of major joints using DICOM images from PACS. Future work could be extended to identify all radiographic images and views.

CLINICAL RELEVANCE/APPLICATION

Deep learning can enhance PACS through automated labeling of radiographs and identification of relevant comparisons, improving hanging protocols and radiologist workflow.

SSG09-06 Prediction of Osteoporotic Vertebral Fractures from Calcaneal Images using Deep Learning

Tuesday, Nov. 28 11:20AM - 11:30AM Room: E450B

Participants
John H. Lee, PhD, Chicago, IL (*Presenter*) Nothing to Disclose
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PURPOSE

The purpose of this work is to evaluate a classifier that predicts bone fragility as assessed by prevalent vertebral fractures shown on vertebral fracture assessment (VFA). The classifier uses the trabecular texture extracted from digital radiographic calcaneal images with a deep convolutional neural network (CNN). The performance of CNN-extracted features is compared to bone mineral density (BMD).

METHOD AND MATERIALS

The clinical dataset consists of digital radiographic images of the calcaneus obtained using a peripheral instantaneous X-ray Imager (PIXI) from 900 patients who had undergone vertebral fracture assessment and BMD measurements. For each calcaneal image, a region of interest (ROI) is manually identified and input to a CNN for trabecular texture extraction. Two classifiers based on different CNNs are evaluated: a CNN that has been pre-trained and a CNN that has been pre-trained then fine-tuned. Fine-tuning leverages data augmentation with images that have been generated using a CNN-based texture synthesis method. For both classifiers, the extracted features from CNN are input to a two-class support vector machine (SVM). Five-fold cross validation is used to assess the performance in predicting vertebral fracture, with area under the receiver operating characteristic curve (AUC) as the performance metric.

RESULTS

The SVM based on features extracted with a pre-trained-only CNN achieved AUC of 0.61 (95% CI: 0.57 - 0.63), which is similar to the one based on BMD (0.62, 95% CI: 0.52 - 0.73). The classifier using features extracted with a fine-tuned CNN is still being developed, but it is expected to perform significantly better than the features extracted with a pre-trained-only CNN as well as the BMD.

CONCLUSION

The comparable performance of the features extracted with a pre-trained CNN shows strong promise for using CNN-extracted trabecular texture to evaluate bone fragility in osteoporotic patients. Given the performance using the pre-trained CNN, significant improvement is expected for a fine-tuned CNN.

CLINICAL RELEVANCE/APPLICATION

Predicting the risk of fracture in osteoporotic patients is a challenging problem, which is clearly demonstrated by the relatively low AUC for classifier based on BMD, despite it being the current clinically-accepted method. Using CNN-extracted features to characterize bone quality and structure show great potential to enhance the current clinical standard.

SSG09-07 Detection and Measurement of Prevertebral Stripe in Cervical Lateral View Using Deep Learning

Tuesday, Nov. 28 11:30AM - 11:40AM Room: E450B

Participants
Young Han Lee, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
Dosik Hwang, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Sewon Kim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Ho-Taek Song, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Jin-Suck Suh, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To show the feasibility of the deep-learning based convolutional neural networks (CNNs) measurement of prevertebral soft tissue thickness (PSTT) as a radiographic marker of cervical spine injury and to correlate CNNs measurements with radiologist's measurements.

METHOD AND MATERIALS

Following institutional review board approval, 200 cervical lateral radiographs were included for training dataset. The prevertebral lines and anterior vertebral lines were annotated by one musculoskeletal radiologist. Two separate pipelines were configured and

trained for extraction and measurement of PSTT at the levels of C2 and C6, using the U-net based CNNs. Consecutive 134 patients who were undertaken cervical lateral radiographs in emergency department were included for test dataset. In the test dataset, the PSTT were measured by the U-net based CNNs model trained from the 200 training dataset. The PSTT were also measured by a musculoskeletal radiologist as reference values. For statistical analyses, Pearson's correlation test and intraclass correlation (ICC) were conducted to correlate the measure values between the CNNs-based measurement and radiologist's measurement. Diagnostic performances of the CNNs-based measurement were evaluated.

RESULTS

U-net based CNNs successfully extract the PSTT (n=130/134, 97%). In the total 130 radiographs, the CNNs-based measurements showed a good correlation at the C2 (r=0.88, p<0.05 and ICC =0.94) and C6 (r=0.48, p<0.05 and ICC=0.62). There were false positives on CNNs measurement (positive on CNNs measurement and negative on radiologist's measurement) in eight radiographs. The detection sensitivity, specificity, and accuracy were 100%, 93.6%, and 96.8%.

CONCLUSION

The CNNs measurements can be clinically utilized in measurement of PSTT by training a deep learning-based pipeline for depicting the PSTT.

CLINICAL RELEVANCE/APPLICATION

The CNNs measurements can be a complementary tool providing timely accurate labels that only require rapid confirmation for busy physician or radiologist.

SSG09-08 Performance of Deep Convolutional Neural Network Based Classifiers in Automated Evaluation of Anterior Shoulder Dislocation and Occult Radial Head Fracture

Tuesday, Nov. 28 11:40AM - 11:50AM Room: E450B

Awards
Student Travel Stipend Award

Participants
Ali B. Syed, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
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PURPOSE

Anterior shoulder dislocation and occult radial head fracture are two common findings on Emergency Department (ED) radiography. Our purpose was to develop convolutional neural network (CNN) based classifiers for these diagnoses and characterize their performance.

METHOD AND MATERIALS

102 de-identified internal rotation radiographs of the shoulder were obtained (51 with anterior dislocation, 51 normal). Similarly, 97 de-identified lateral radiographs of the elbow were obtained, 47 of which showed anterior joint effusions in the presence of trauma; remaining 50 were normal. Diagnoses were verified by a board-certified radiologist. These data sets were augmented 12x via multiple rotations as well as contrast equalization and non-rigid deformation. Images were used to train classifiers using both AlexNet and GoogLeNet CNN architectures using the Caffe framework. 20% of the augmented data sets were used in validation. Separate test data sets consisting of 60 shoulder and 60 elbow radiographs (each 50% pathology, 50% normal) were used to assess performance. Receiver operating characteristic (ROC) curves were generated and area under the curve (AUC), sensitivity, and specificity were computed. Differences in AUCs were obtained with a statistical significance threshold of 0.05.

RESULTS

Shoulder dislocation classifier ROC curve demonstrated an AUC of 0.997 with a p-value of 3.7e-11, sensitivity of 96.7%, and specificity of 100%. The elbow classifier AUC was 0.50 with a sensitivity of 23.3% and a specificity of 83.3%.

CONCLUSION

Our shoulder dislocation classifier shows near-perfect accuracy and may be particularly useful to the growing number of non-radiologists that interpret radiographs in the emergency setting; such a classifier may also be useful in identifying shoulder dislocation as an incidental finding on other imaging (e.g. chest radiographs). In contrast, detection of elbow effusions is a task that demands higher visual discrimination and as such likely requires additional preprocessing and a greater number of training cases than present in our current study. Comparison of the results of our shoulder and elbow classifiers is illustrative of the strengths and weaknesses of currently available CNN architectures and training methods.

CLINICAL RELEVANCE/APPLICATION

Deep convolutional neural networks can detect anterior shoulder dislocation with near-perfect accuracy and can thus aid in expeditious diagnosis in an emergency setting.

SSG09-09 Deep Learning For Detection of Full Thickness Anterior Cruciate Ligament Tear

Tuesday, Nov. 28 11:50AM - 12:00PM Room: E450B

Participants
Peter Chang, MD, Bronx, NY (*Presenter*) Nothing to Disclose
Tony T. Wong, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Michael J. Rasiej, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the feasibility of an automated deep learning artificial intelligence algorithm to detect full thickness anterior cruciate ligament (ACL) tears.

METHOD AND MATERIALS

One hundred (N = 100) patients between 18 and 40 years old with a full thickness ACL tear were identified in a retrospective review of knee MRIs obtained between September 2013 and March 2016. A second control group of one hundred (N = 100) normal patients was identified with no ACL pathology. All two hundred ACL diagnoses were confirmed through visual inspection by a board-certified subspecialist musculoskeletal radiologist (MJR). For each exam with an ACL tear, coronal proton density (PD) non-fat suppressed sequences were manually annotated to delineate: (1) a bounding-box around the cruciate ligaments; (2) slices containing an ACL tear. Based on this, a two-step convolutional neural network (CNN) was trained to: (1) identify the ACL; (2) assign a binary classification to each patient depending on the presence or absence of an ACL tear (Figure 1). The CNN is based on a generative-adversarial network for semi-supervised learning utilizing feature-matching. Both 2D and 3D CNNs were evaluated.

RESULTS

The two hundred MR volumes yielded a total of 3184 coronal PD slices, 480 slices of which contained an ACL tear. Of the two tested architectures, the 3D CNN model performed better, classifying 89.5% of patients correctly based on a five-fold validation. The 2D CNN model classified 78% of patients correctly (417/480 slices). Both CNN models were trained for 500 epochs with a batch size of 32. The final trained 3D CNN can generate predictions for all 200 patients in 287 seconds (1.4 seconds per patient).

CONCLUSION

A deep learning CNN model can evaluate for the presence of a full thickness ACL tear with reasonable accuracy. A 3D model outperforms a 2D model, suggesting that detection of an ACL tear may be limited when using a single coronal MR slice and benefits from the context of adjacent slices. Further work will focus on evaluating deep learning models for assessing and quantifying lower grade ACL and other ligamentous injuries.

CLINICAL RELEVANCE/APPLICATION

Anterior cruciate ligament tears are commonly encountered injuries in sports medicine with significant morbidity. This is the first time a deep machine learning algorithm has been used to evaluate ACL injuries.

SSG10

Nuclear Medicine (Gastrointestinal, Lymphoma and Melanoma Imaging)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S505AB

CT GI NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.00

Participants
Frederik L. Giesel, MD, MBA, Heidelberg, Germany (*Moderator*) Patent application for F18-PSMA-1007
Farrokh Dehdashti, MD, Saint Louis, MO (*Moderator*) Nothing to Disclose

Sub-Events

SSG10-01 Initial Experience with a New PET/CT System Using SiPM Detectors

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S505AB

Participants
Sonya Y. Park, MD, Stanford, CA (*Presenter*) Nothing to Disclose
Lucia Baratto, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Negin Hatami, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Guido A. Davidzon, MD, MS, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Shyam Srinivas, MD, PhD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
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Andrei Iagaru, MD, Stanford, CA (*Abstract Co-Author*) Research Grant, General Electric Company

PURPOSE

We installed the first worldwide of a new digital PET/CT system that brings together silicon photomultiplier (SiPM) technology with time-of-flight (TOF) and block sequential regularized expectation maximization (BSREM, Q.Clear®). We report our initial clinical experience using the Discovery Meaningful Insights (DMI) scanner and evaluate the image quality in comparison to standard PET/CT scanners with and without TOF capability.

METHOD AND MATERIALS

Seventy-three patients were scanned first on the standard of carePET/CT followed immediately by a scan on the new digitalPET/CT system using the same scan time per field of view. Images from the digital PET/CT were reconstructed using a conventional (non-TOF) algorithm, TOF alone and TOF in combination with Q.Clear®. Images from the standard of care PET/CT were reconstructed using clinical standard of care settings. Three blinded readers randomly reviewed four datasets per patient for image quality using a 5-point Likert scale: standard, DMInon-TOF, DMITOF and DMITOF+Q.Clear. Standardized uptake value (SUV) measurements for the single most avid lesion on each dataset were also recorded.

RESULTS

In this side-by-side comparison, datasets from the DMI showed higher image quality ($P<0.001$) and SUV measurements compared with the standard of care systems. Scores were further improved when TOF and Q.Clear® algorithms were added for image reconstruction. Of clinical interest, nine patients demonstrated lesions that could only be visualized on images from the DMI. Noticeably less respiratory artifacts at the diaphragm were also reported in the TOF-reconstructed images.

CONCLUSION

The new digital PET/CT system outperforms the standard of care scanners in terms of image quality, with further benefits added by the use of TOF and Q.Clear® reconstruction algorithms. This may be most beneficial in detecting small lesions and may result in more accurate disease staging.

CLINICAL RELEVANCE/APPLICATION

The new digital PET/CT system with SiPM technology and updated reconstruction algorithms provides better image quality and resolution, and is recommended for evaluation of all patients.

SSG10-02 Diagnostic Performance Of 68Ga-DOTATATE PET/CT in Evaluation of Neuroendocrine Malignancies: What Parameters Are Useful?

Tuesday, Nov. 28 10:40AM - 10:50AM Room: S505AB

Participants
Farshad Moradi, MD, San Diego, CA (*Presenter*) Nothing to Disclose
Andrei Iagaru, MD, Stanford, CA (*Abstract Co-Author*) Research Grant, General Electric Company

PURPOSE

We had previously shown that normal biodistribution of 68Ga-DOTATATE and uptake in neuroendocrine tumors are both variable

We had previously shown that normal biodistribution of 68Ga-DOTATATE and uptake in neuroendocrine tumors are both variable among patients. The aim of this study is to systematically investigate the diagnostic performance of SUVmax and tumor-to-tissue uptake ratios (SUVR) for discrimination of benign versus malignant lesions.

METHOD AND MATERIALS

68Ga-DOTATE PET/CT was performed in 104 patients with clinically suspected or confirmed neuroendocrine malignancies. Benignity/malignancy of lesions with focal uptake were determined by histopathology or clinical follow up. Receiver operating characteristic (ROC) curves were constructed for SUVmax and uptake ratios normalized to physiologic activity in different tissues. Areas under the ROC curves (AUC) were calculated and compared for various parameters.

RESULTS

A total of 127 benign and 497 malignant lesions with focal uptake were identified. SUVmax yielded an area under ROC curve of 0.94 (corresponding to sensitivity and specificity of 88% at a cutoff of 6.4 g/mL). Sixty percent of malignant lesions (and none of the benign ones) had intense uptake (SUVmax>15). Diagnostic performance was lower when these lesions were excluded (sensitivity and specificity of 80% at a cutoff of 5 g/mL). Similar diagnostic performance was obtained using tumor-to-liver (AUC=0.95, p>0.05) or tumor-to-adrenal uptake ratio (AUC=0.95, p>0.05). Diagnostic performance decreased when activity was normalized to blood pool (AUC=0.93, p<0.02). Normalizing to pancreas, renal parenchyma, or splenic uptake yielded areas under the ROC curve that were not significantly superior to tumor-to-blood pool uptake ratio.

CONCLUSION

Intense uptake on 68Ga-DOTATATE PET/CT is highly specific for neuroendocrine malignancies. SUVmax and tumor-to-liver uptake ratio yield comparable diagnostic performance that is superior to tumor-to-blood pool uptake ratio for determining malignancy.

CLINICAL RELEVANCE/APPLICATION

Liver uptake can be used for normalization of lesion activity in 68Ga-DOTATATE PET/CT.

SSG10-03 Integrated Time-Of-Flight FDG PET/MRI-MRCP for Evaluation of Distant Metastases in Patients with Pancreatic Cancer and Elevated CA 19-9: A Feasibility Study

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S505AB

Awards
Student Travel Stipend Award

Participants
Ishan Garg, MBBS, Rochester, MN (*Presenter*) Nothing to Disclose
Geoffrey B. Johnson, MD, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
Mark Truty, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
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Bradley J. Kemp, PhD, London, ON (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the feasibility and diagnostic performance of integrated FDG PET/MRI-MRCP for distant metastases in patients with pancreatic cancer and elevated CA 19-9.

METHOD AND MATERIALS

46 pancreatic cancer patients underwent FDG PET/MR on a 3.0 T time-of-flight PET/MRI (SIGNATM, GE Healthcare) (04/2016-11/2016). Of these, 23 patients (65.2% females; mean age: 62.9-years, range 46-79) had elevated CA 19-9 (>55 U/mL) and constituted study cohort. Imaging protocol consisted of multi-bed position whole body survey (2-3 minutes/bed) with an additional 15-minute single bed position respiratory-compensated focused abdominal PET. MR component included respiratory-navigated T2W, DWI, IDEAL-IQ, MRCP and breath-hold post-contrast dynamic sequences (average protocol duration ~ 60-minutes). PET/MR findings were compared with that of CT performed within 3-weeks of PET/MR. Final diagnosis was established using a composite pathologic and clinico-radiological reference standard.

RESULTS

PET/MR was positive for metastatic disease in 7 (30.4%) patients. In 3 patients (13%), PET/MR detected all metastatic lesions (liver, adrenal and peritoneal) that were also detected on CT. In 2 patients (8.7%), PET/MR detected additional 7 hepatic metastases (size: 5-mm to 1.8-cm) that were occult on multiphase CT performed within one-week of PET/MR. In the first of these two patients, management changed from planned neo-adjuvant therapy to that of palliative chemotherapy while in the other patient it changed from planned observation to that of palliative chemotherapy. One patient (4.3%) had a biopsy-proven false-positive liver lesion on PET/MR.

CONCLUSION

Integrated FDG PET/MRI-MRCP is feasible for evaluation of distant metastases in patients with pancreatic cancer. In our preliminary cohort, PET/MR detected additional hepatic metastases that were occult on CT in patients with pancreatic cancer and elevated CA 19-9.

CLINICAL RELEVANCE/APPLICATION

Integrated FDG PET/MRI-MRCP combining whole body and liver-specific imaging is feasible in clinical practice. When compared with CT, this hybrid modality has the potential to detect occult metastases that change clinical management in patients with pancreatic cancer.

SSG10-04 A Pilot Study of Patterns of Response to Immune Checkpoint Inhibitor Therapy in Patients with Hodgkin Lymphoma Treated with PD1i

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S505AB

Awards
Trainee Research Prize - Fellow

Participants
Laurent Dercle, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

In patients with Hodgkin Lymphoma [HL], the response evaluation criteria were designed for the assessment of chemotherapy and targeted molecular agents. Anti-Programmed Death 1 antibodies [PD1i] are immune-checkpoint inhibitors which improve patients outcome but lead to new immune pattern of response. We investigated the accuracy of 3-month-FDG-PET/CT for response classification and the frequency of new patterns of response in HL patients treated with PD1i.

METHOD AND MATERIALS

The FDG-PETs and CTs data of all consecutive r/rHL patients treated by PD1i (Pembrolizumab or Nivolumab), from 2013-2015 were retrospectively reviewed according to Cheson 2014 criteria and LYRIC 2016 revised criteria. Patients achieving an objective response at any time of treatment were classified as immune-responding, otherwise they were classified as immune-refractory. The variation in imaging features on FDG-PET and contrast-enhanced CT-scans were measured every three months.

RESULTS

Sixteen patients were included, median age was 39 (19-69) years, and the median of previous lines of therapy was 6 (3-13). With a mean follow-up of 22.6 months and an estimated overall survival of 34.7 months, two deaths occurred, both of progressive disease. All the nine out of sixteen (56%) immune-responding patients achieved an objective response at 3-month that translated into a significant decreased tumor metabolism (ΔSUVmean), decreased metabolic tumor volume (ΔMTV), and increased healthy splenic metabolism (ΔSUVmax). The respective AUC [95CI] of these 3-month-FDG-PET biomarkers was 0.89 [.72-1.0] (p=0.01), 0.98 [.90-1.0] (p=0.005) and 0.85 [.63-1.0] (p=0.04) for response classification. Five out of 16 patients (31%) displayed new imaging patterns related to PD1i; we observed two transient progressions consistent with indeterminate response according to the LYRIC 2016 criteria (IR2b at 14-month and one IR3 at 18-month), and three patients with new lesions related to immune-related adverse events.

CONCLUSION

FDG-PET/CTs detect immune-responding HL patients at 3 months. New imaging immune-patterns were encountered in 31% of patients, encouraging a close cooperation with clinicians.

CLINICAL RELEVANCE/APPLICATION

In Hodgkin Lymphoma, 3-month-FDG-PET/CT is accurate for classification of response to PD1i immune-checkpoint inhibitors although new immune patterns of response are observed in 31% of patients.

SSG10-05 Whole-Body MRI Including Diffusion-Weighted Imaging for Pretherapeutic Assessment and Staging of Low Grade Lymphoma: Results of a Prospective Study in 30 Patients

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S505AB

Participants
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PURPOSE

To determine the clinical utility of whole-body MRI (WB-MRI) in the pretherapeutic imaging and staging of low grade lymphoma with low FDG avidity.

METHOD AND MATERIALS

This prospective study included 30 treatment-naive patients with low grade lymphoma (14 follicular, 14 extranodal marginal zone B-cell lymphoma of the mucosa-associated lymphoid tissue(MALT), 1 small lymphocytic lymphoma and 1 nodal marginal zone lymphoma), who underwent WB-MRI (DWI and T2-weighted STIR) and FDG-PET/CT. WB-MRI and FDG-PET/CT were independently evaluated by each two blinded observers. Region-based sensitivity and the staging, relative to the reference standard, given by

each technique were compared in Group A (whole-body regions) and Group B (whole-body regions excluding bone marrow). Difference in staging were resolved using biopsy, and clinical and CT follow-ups as standard of reference.

RESULTS

WB-MRI and FDG-PET/CT had region-based sensitivities of 87.4 - 88.9% and 82.3 - 84.4% in Group A, and 93.4 - 95.1% and 89.3 - 91.8% in Group B, respectively. WB-MRI and FDG-PET/CT agreed with the reference standard in 73.3% (k, 0.64) and 66.7% - 70% (k, 0.56-0.60) in Group A, and 100% (k, 0.96) and 96.7-100 % (k,0.96), respectively. The kappa values for interobserver agreement on WB-MRI and FDG-PET/CT were 0.985 and 0.867 in Group A, and 0.984 and 0.863 in Group B, respectively.

CONCLUSION

In patients with low grade lymphoma with a low FDG avidity, WB-MRI and FDG-PET/CT have similar performance with regard to pretherapeutic regional assessment and staging. However, both of WB-MRI and FDG-PET/CT seems to be limited in terms of bone marrow evaluation.

CLINICAL RELEVANCE/APPLICATION

Whole-body MRI is a feasible alternative to FDG-PET/CT for staging of less FDG-avid low grade lymphoma.

SSG10-06 Prediction of Treatment Response and Recurrence after Chemotherapy with Texture Analysis or Volumetric Parameters on FDG PET in Patients with Follicular Lymphoma

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S505AB

Participants
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PURPOSE

To evaluate if texture features(TFs) or volumetric parameters(VPs) on FDG PET were useful in predicting treatment response and recurrence after chemotherapy(Cx) in patients with follicular lymphoma(FL).

METHOD AND MATERIALS

45 FL patients having pre- and postCx FDG PET/CT exams were included in this study. They had at least one lesion with metabolic tumor volume(MTV, SUV threshold 2.5) >5 ml in preCx PET exams for accurate analysis. PreCx PET images were analyzed retrospectively. TFs were obtained from a 3D ROI covering the hottest lesion in each preCx exam. TFs evaluated in this study included homogeneity, entropy, and dissimilarity as local heterogeneity parameters, and short- and long-run emphasis, low- and high gray-level zone emphasis, intensity variability, size-zone variability, and zone percentage as regional heterogeneity parameters. MTV and total lesion glycolysis(TLG) were calculated as VPs for the hottest as well as whole-body lesions in addition to SUVmax. Values of these parameters were compared each other and were evaluated as to prediction of Cx response, i.e. complete response(CR) or not(non-CR), which was determined with Lugano classification using postCx PET results. They were also evaluated as to recurrence within 2 years.

RESULTS

23 and 22 pts showed CR and non-CR, respectively, after Cx. All TFs correlated with VPs or SUVmax, except for homogeneity or low gray-level zone emphasis(LGZE) v.s. SUVmax. The values of LGZE in CR pts were significantly higher than those in non-CR pts($p<0.05$). No difference was observed in other TFs, VPs, or SUVmax between CR and non-CR pts. ROC analysis revealed LGZE the best parameter to predict CR after Cx(AUC:0.72, sen.64%, spe.70%, acc.67%). Lugano classification scores exhibited a weak correlation with long-run emphasis(rho:0.3) or zone percentage(rho:-0.3)($p<0.05$, Spearman). 25 of 45FL pts showed recurrence within 2 years. None of TFs, VPs, and SUVmax allowed prediction of the recurrence.

CONCLUSION

This study demonstrated that texture analysis on preCx FDG PET was useful and better than VPs and SUVmax in predicting treatment response. However, none of preCx PET parameters allowed prediction of recurrence in this FL pts population.

CLINICAL RELEVANCE/APPLICATION

Texture analysis on FDG PET before treatment was demonstrated to be useful and better than volumetric parameters and SUVmax in predicting treatment response of chemotherapy in follicular lymphoma patients.

SSG10-07 Comparison of Quantitative Parameters and Deauville 5 Point Score from 18F-FDG PET/CT Scans in Patients with Follicular Lymphoma

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S505AB

Participants
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PURPOSE

To compare the quantitative PET parameters and Deauville 5 point score of interim and end-of-therapy FDG PET/CT studies in patients with follicular lymphoma.

METHOD AND MATERIALS

18Fluoro-deoxy-glucose positron emission tomography/computed tomography (FDG PET/CT) images of 38 consecutive patients with newly diagnosed follicular lymphoma between 2013 to 2015 at a single institution were retrospectively reviewed. 8 patients did not have sufficient follow-up information. 3 patients could not be evaluated because the PET images from outside sites were corrupted. Deauville 5 point score (D5PS), maximum standardized uptake value (SUVmax), peak standard uptake value corrected for lean body mass (SULpeak), and tumor to liver ratio (T/L ratio) were assigned to the interim and end-of-therapy PET/CT studies of 27 patients. Patient with D5PS of 1, 2, and 3 were considered as responders, and those with D5PS of 4 and 5 were considered as 'nonresponders'. We compared changes in quantitative PET parameters with the D5PS assessments.

RESULTS

Of 27 patients (age mean 48.9 yrs, range 29-71 yrs; 15 male and 12 female), 14 received R-CVP and 13 received R-CHOP as first line therapy. The clinical stages were stage I, n=1; stage II, n= 1; stage III, n=10; and stage IV, n=15. According to interim PET, 17 patients were responders and 10 were nonresponders. At end-of-therapy, 23 patients were responders, and 4 were nonresponders. The absolute and percent decrease in the PET parameters between responders and nonresponders were as in table 1. There were 10 nonresponders on interim PET, and 6 patients achieved response at end-of-therapy (5 patients on R-CVP and 1 received R-CHOP), while 4 patients were nonresponders at end-of-therapy as well (all 4 on R-CHOP). There was no particular PET parameter threshold that could predict the end-of-therapy response.

CONCLUSION

For patients with follicular lymphoma, quantitative assessment in PET/CT was not be of value in differentiating interim responders and nonresponders and did not show significant association with D5PS.

CLINICAL RELEVANCE/APPLICATION

Quantitative assessment in FDG PET/CT was not be of value in differentiating interim responders and nonresponders in patients with follicular lymphoma.

SSG10-08 Time Course of FDG-PET/CT Findings in Extranodal Mucosa-Associated Lympoid Tissue Lymphoma in the Thyroid Treated By Radiotherapy

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S505AB

Participants
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PURPOSE

Radiotherapy (RT) is an useful treatment for malignant lymphoma with localized disease. Aim of study was to evaluate time course of FDG-PET/CT findings in patients with extranodal mucosa-associated lymphoid tissue (MALT) lymphoma in the thyroid who underwent RT.

METHOD AND MATERIALS

34 patients (M/F 7/27, age 45-77yrs.) with primary MALT lymphoma of the thyroid were included. None of the patients were associated with diabetes. Either or both of TgAb and TPOAb were positive in all. Clinical stage was IE in 24, and was IIE in 10. The dose of RT was 40Gy/20f (30Gy for the whole neck with additional 10Gy to the thyroid gland). Follow up period ranged 16-80 mos. FDG-PET/CT was performed 5 times; before RT (PET/CTpre), 3-5mos. after RT (PET/CT1, n=34), 15-20mos. after RT (PET/CT2, n=32), 32-48mos. after RT (PET/CT3, n=25), and 58-73 mos. after RT (PE/CT4, n=18). Both visual interpretation and semi-quantitative analysis with SUVmax were performed by 2 independent nuclear medicine physicians. Negative FDG uptake, which was considered as a sign for absence of viable tumor, was defined as thyroidal FDG uptake less intensive than that of the mediastinum or SUVmax of less than 3.5. Therapeutic outcome was confirmed by biopsy in 17 pts. and by clinical examination and imaging modalities in the remaining 17.

RESULTS

On PET/CTpre images, positive FDG uptake in the thyroid was positive in all patients with nodular appearance in 14 (41%) and diffuse appearance in 20 (59%). After RT, CR was achieved in 32 out of 34 pts (94%).Among the patients with CR, negative FDG uptake on PET1, 2, 3, and 4 was seen in 6/32 (19%), 11/32 (36%), 15/25 (60%), and 9/18 (50%), respectively by visual interpretation. Likewise, negative FDG uptake on PET 1,2, and 3 was achieved in 4/32 (32%), 8/32 (25%), 11/25 (44%), and 9/18 (50%), respectively by semi-quantitative analysis.9 out of 18 pts. (50%) showed persistent thyroidal FDG uptake even on PET/CT4 by visual and semi-quantitative evaluation. Appearance of FDG uptake was diffuse in all.

CONCLUSION

RT was a valuable treatment against thyroid MALT lymphoma with l stage I or II disease. However, 50% of the patients with CR showed positive FDG uptake persisting for more than 4 yrs. after RT. Post-therapeutic FDG-PET/CT findings must be interpreted with caution in thyroid MALT lymphoma treated by RT.

CLINICAL RELEVANCE/APPLICATION

FDG-PET/CT has a limited value in response assessment of RT for thyroid MALT lymphoma .

SSG10-09 Correlation of 18F-FDG Uptake in Lymphoid Organs Early After PD1-Therapy Initiation to Therapy Response and Baseline Biomarkers in Melanoma: Preliminary Results of an Ongoing Study

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S505AB

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PURPOSE

Aim of our study was to evaluate if relative changes of 18F-FDG uptake in the liver, the spleen and the bone marrow 2 weeks after PD1-therapy initiation compared to the baseline scan correlate to baseline biomarkers and to therapy outcome after three months.

METHOD AND MATERIALS

We performed a subgroup analysis of 10 patients (4 f; 64±11 y) with metastasized melanoma treated with anti-PD1-antibodies out of a prospectively conducted ongoing study. All patients were examined in a whole-body 18F-FDG-PET/MRI before the therapy start (t0), two weeks (t1) and three months after the treatment initiation (t2). If not metastatically involved in any of the timepoints, the 18F-FDG-uptake in the liver, the spleen and the bone marrow were acquired. Therapy response was assessed with PET response criteria in solid tumors (PERCIST) at t2. The relative eosinophil count (REC), relative lymphocyte count (RLV) and the neutrophile-lymphocyte-ratio (NLR) were assessed during the week before therapy initiation.

RESULTS

At t2, progressive metabolic disease (PMD) was seen in six patients, stable metabolic disease (SMD) was seen in two patients and three patients showed complete metabolic response (CMR). Therapy responders (CMR and SMD at t2) showed a significant summed relative increase of 18F-FDG-uptake in the investigated organs of +28% ($p<0.003$) while non-responders (PMD) showed no significant change ($p=0.65$). The relative change of 18F-FDG-uptake at t1 of the liver showed the best correlation to REC ($R=0.78$), RLC ($R=0.50$) and NLR ($R=-0.44$).

CONCLUSION

Our preliminary results let assume that an increased uptake of 18F-FDG-PET in the liver, the spleen and the bone marrow two weeks after therapy initiation might indicate a therapy response in patients treated with anti-PD1-antibodies. This has to be proven in a larger patient cohort.

CLINICAL RELEVANCE/APPLICATION

Increased 18F-FDG uptake in lymphoid organs early after therapy initiation might help to identify reponders to anti-PD1-therapy.

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SSG11

Neuroradiology (Molecular Neuroimaging: From Diffusion to Beyond)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: N229

CT MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSG11-01 MR-NODDI Evaluating Amyotrophic Lateral Sclerosis: A Tract Based Spatial Statistics Analysis

Tuesday, Nov. 28 10:30AM - 10:40AM Room: N229

Participants
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PURPOSE

Amyotrophic lateral sclerosis (ALS) is an incredibly lethal disease and resistant to therapy. Symptoms of ALS can be similar to those of a wide variety of other, more treatable diseases or disorders. The aim of this study is to use neurite orientation dispersion and density imaging (NODDI), a novel tool, to quantify changes of white matter (WM) skeleton in patients with ALS compared to healthy controls.

METHOD AND MATERIALS

Two shells of diffusion-weighted magnetic resonance images (shell 1: b=1000s/mm2, direction=25; shell 2: b=2500s/mm2, direction=25) were acquired from 12 patients with ALS and 12 age- and sex-matched healthy controls. FMRIB's Linear Image Registration Tool was used to register all diffusion-weighted volumes to their corresponding b = 0 s/mm2 volume, and to correct for motion and eddy currents. The Brain Extraction Tool was used to remove non-brain tissue, FSL's DTIFIT was used to calculate FA, and NODDI toolbox was used to calculate the intra-neurite volume fraction (Ficvf) and orientation dispersion index (ODI). FSL's Tract-Based Spatial Statistics (TBSS) tool was used to align individual FA maps to FSL's standard adult FA template. Following registration, the FA maps of all subjects were thinned to create white matter skeletons. Then, Ficvf and ODI maps were created and registered using the TBSS registrations of FA to the adult FA template, and the skeleton mask was applied to the registered images. The white matter skeletons differences in FA, Ficvf and ODI were compared between ALS patients and healthy controls.

RESULTS

In the TBSS analysis, significant FA reductions were demonstrated within the (pre)frontal WM, partial parietal WM, corpus callosum and partial corticospinal tract (with TFCE-correction). Similarly, significant Ficvf reductions were found within almost all the WM skeleton (with TFCE-correction), which was more extensive than that of FA. In contrast, ODI showed no significant changes in all the WM skeleton.

CONCLUSION

NODDI is a more potential tool to demonstrating the neurite density reductions for ALS patients. Significant Ficvf reductions can be observed within almost all the WM skeleton, which indicates the reductions of the neurite density in the corresponding WM. Ficvf found more extensive changes than FA, indicating Ficvf is a more sensitive parameter.

CLINICAL RELEVANCE/APPLICATION

NODDI will help lead to earlier diagnosis and treatment for ALS.

SSG11-02 Histogram Analysis of Diffusion Kurtosis Imaging of Nasopharyngeal Carcinoma: Correlation between Quantitative Parameters and Clinical Stage

Tuesday, Nov. 28 10:40AM - 10:50AM Room: N229

Participants
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PURPOSE

To evaluate the correlation between histogram parameters derived from diffusion-kurtosis (DK) imaging and the clinical stage of nasopharyngeal carcinoma (NPC).

METHOD AND MATERIALS

DK imaging data of forty-seven consecutive NPC patients were retrospectively analyzed. Apparent diffusion for Gaussian distribution (Dapp) and apparent kurtosis coefficient (Kapp) were generated using diffusion-kurtosis model. Histogram parameters, including mean, median, 10th, 90th percentiles, skewness and kurtosis of Dapp and Kapp were calculated. Patients were divided into low and high T, N and clinical stage based on American Joint Committee on Cancer (AJCC) staging system. Differences of histogram parameters between low and high T, N and AJCC stages were compared using t test. Multiple receiver operating characteristic (ROC) curves were used to determine and compare the value of significant parameters in predicting high T, N and AJCC stage, respectively.

RESULTS

High T-stage (T3/4) NPC showed significantly higher Kapp-mean (P=0.018), Kapp-median (P=0.029) and Kapp-90th (P=0.003) than low T-stage (T1/2) NPC. High N-stage NPC (N2/3) showed significantly lower Dapp-mean (P=0.002), Dapp-median (P=0.002) and Dapp-10th (P<0.001) than low N-stage NPC (N0/1). High AJCC-stage NPC (III/IV) showed significantly lower Dapp-10th (P=0.038) than low AJCC-stage NPC (I/II). ROC analyses indicated that Kapp-90th was optimal for predicting high T-stage (AUC, 0.759; sensitivity, 0.842; specificity, 0.607), while Dapp-10th was best for predicting high N- and AJCC-stage (N-stage, AUC, 0.841; sensitivity, 0.875; specificity, 0.807; AJCC-stage, AUC, 0.671; sensitivity, 0.800; specificity, 0.588).

CONCLUSION

DK imaging-derived parameters correlated well with clinical stage of NPC, therefore could serve as an adjunctive imaging technique for evaluating NPC.

CLINICAL RELEVANCE/APPLICATION

DK imaging-derived histogram parameters were useful for characterizing NPC, and correlated well with the clinical stage of the NPC patients. Dapp-10th was optimal for predicting the high N- and AJCC-stage, while Kapp-90th was most powerful for predicting the high T-stage. Our results suggested that DK imaging-derived parameters could be a potential imaging marker for pretreatment staging, and DK imaging could be a useful adjunctive imaging technique for evaluating NPC before treatment.

SSG11-03 Cerebral Sodium (23Na) Magnetic Resonance Imaging in Patients with Migraine vs Healthy Controls

Tuesday, Nov. 28 10:50AM - 11:00AM Room: N229

Participants
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PURPOSE

Evaluation of 23Na concentrations in patients with clinically manifest migraine vs. healthy controls.

METHOD AND MATERIALS

In this prospective, IRB-approved study we recruited 12 patients (all female; mean age 34±11 years) who have been clinically evaluated for migraine and who have filled out a questionnaire regarding onset of disease, length, intensity (scale 1-10) and frequency of attacks and accompanying aura, as well as 12 healthy controls (all female; mean age 34±11 years). Both groups underwent a cerebral 23Na-magnetic resonance imaging examination at 3.0T (TimTrio, Siemens Healthcare Sector). For each scan a non-contrast enhanced T1w MP-RAGE sequence for anatomical referencing and a 3D-density-adapted, radial gradient echo (GRE-) sequence for 23Na-imaging were acquired using a double-tuned (1H/23Na), dedicated head-coil. 23Na-sequences were reconstructed according to the MP-RAGE, allowing direct cross-referencing of regions-of-interest (ROI). Circular ROIs were placed in predetermined anatomic regions: anterior and posterior cerebrospinal fluid (CSF), grey and white matter (GM/WM), brain stem and cerebellum. External 23Na reference phantoms were used to calculate the 23Na tissue concentrations. 23Na concentrations of migraine patients and healthy controls were compared and statistically analyzed by Wilcoxon rank sum test.

RESULTS

Overall 23Na concentrations (in millimoles per liter) in the anterior CSF region of patients with manifest migraine were significantly higher with 79±7 vs. 69±4 in healthy controls (p=0.0001) (see figure 1). Similar findings were found for the posterior CSF region with 23Na concentrations of 85±6 in migraine patients vs. 63±8 in healthy controls (p=0.0013). No statistical difference was found for 23Na concentrations in the grey and white matter, brain stem and cerebellum.

CONCLUSION

Cerebral 23Na concentrations in CSF of migraine patients are significantly higher than in healthy controls.

CLINICAL RELEVANCE/APPLICATION

Cerebral 23Na MRI may be a potential imaging tool for the diagnosis of migraine.

SSG11-04 Leakage Correction improves Prognosis Prediction of Dynamic Susceptibility Contrast Perfusion MRI in Primary Central Nervous System Lymphoma

Tuesday, Nov. 28 11:00AM - 11:10AM Room: N229

Awards

Student Travel Stipend Award

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PURPOSE

The purpose of this study is to evaluate whether CBV measurement with leakage correction from dynamic susceptibility contrast perfusion weighted image(DSC-PWI) can be useful for the prognosis prediction of primary CNS lymphoma(PCNSL).

METHOD AND MATERIALS

Among 130 patients with PCNSL from January 2007 to April 2016, 46 patients were classified by radiation therapy(RT) stratification:non-RT(n=16);RT group(n=30). Patients of both groups were reclassified into progression free survival(PFS) based subgroups by their PFS period:3 years criteria for RT group;1 year criteria for non-RT group. With a dedicated imaging processing program(NordicICE), the normalized cerebral blood volume(nCBV) map with or without leakage correction and leakage map were obtained. Those perfusion maps were co-registered with contrast enhanced T1 weighted image(CET1WI) and fluid attenuated inversion recovery(FLAIR). The total volume of interest(VOI) was drawn on co-registered images corresponding with enhancing lesion on CET1WI or hyperintensity lesion on FLAIR. Histogram analysis was used to calculate the corresponding parameters of the total VOIs. Student's t-test and Mann-Whitney test were used to evaluate significant difference of aforementioned imaging parameters between both groups. The PFS associated with nCBV was analyzed by Kaplan-Meier survival analysis.

RESULTS

The 75th percentile nCBV with leakage correction corresponding on CET1WI(T1nCBVL75%) had significant difference between the short(<3-year) and long(>=3-year) PFS subgroups of RT group(23.3%[7/30]vs76.7%[23/30],P<.05) and between the short(<1-year) and long(>=1-year) PFS subgroups of non-RT group(43.7%[7/16] s56.3%[9/16],P<.05). Patients of RT group with high T1nCBVL75%(> 5.3377) had shorter PFS than the others with low T1nCBVL75%(<= 5.3377)(P<.05). However, patients of non-RT group with high T1nCBVL75%(> 4.2243) had longer PFS than the others with low T1nCBVL75%(<= 4.2243)(P<.05).

CONCLUSION

Based on RT stratification, CBV with leakage correction has potential as a noninvasive biomarker for prognosis prediction of PCNSL to identify high risk patients and has different relationship with PFS based on the presence of combined RT. The high value of CBV with leakage correction correlates with shorter PFS in RT group and with longer PFS in non-RT group.

CLINICAL RELEVANCE/APPLICATION

Pretreated CBV value with leakage correction from DSC-PWI would be helpful to plan for therapeutic strategy in patients with PCNSL.

SSG11-05 Characterization of Parotid Tumors with Arterial Spin Labeling Perfusion-Weighted MR Imaging

Tuesday, Nov. 28 11:10AM - 11:20AM Room: N229

Participants
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PURPOSE

To characterize parotid tumors with arterial spin labeling perfusion-weighted MR imaging

METHOD AND MATERIALS

This study was conducted upon 44 consecutive patients (27M, 21 F aged 15-75 ys: mean 45ys) with parotid tumors that underwent arterial spin labeling perfusion-weighted MR imaging at 1.5 Tesla scanner (Ingenia Philips Nederland). Multi-phases arterial spin labeling with FEEPI sequence was applied. The applied scanning parameters: TR = 250o ms, TE =20 ms, flip angle =35degress, slice thickness = 6 mm, interslice gap=1 mm, NEX=1, FOV=25 cm X 20 cm, SENSE factor=2.5 and scanning time=4 minutes. There was reconstruction of 1200 source images. The tumor blood flow (TBF) of parotid tumors were calculated and correlated with histopathological findings.

RESULTS

The TBF of malignant parotid tumors (37.9±6.19 mL/100 g/min) was significantly different (P= 0.001) from that of benign parotid tumors (14.1±3.12 mL/100 g/min). The threshold values of TBF used in differentiating malignant from benign parotid tumors was 25.5 mL/100 g/min with area under the curve (AUC) of 0.90. The TBF of malignant parotid tumors was significantly different from that of Warthin's tumors (P = 0.001). The cutoff TBF used to differentiate malignancy from Warthin's tumors was 18.7 mL/100 g/min with AUC of 0.88. There was a significant difference in TBF between pleomorphic adenomas and Warthin's tumors (P= 0.041). The threshold values of TBF used in differentiating pleomorphic adenomas from Warthin's tumors was 15.2 mL/100 g/miny with AUC

of 0.88.

CONCLUSION

Arterial spin labeling perfusion-weighted MR imaging is non-invasive promising method that are used for differentiation of malignant from benign parotid tumors and for characterization of some benign parotid tumors.

CLINICAL RELEVANCE/APPLICATION

Arterial spin labeling perfusion-weighted MR imaging can be added to routine MR imaging for better characterization of parotid tumors

SSG11-06 Spectral Dual Energy CT Texture Analysis of Head and Neck Squamous Cell Carcinoma Tumor for Prediction of Cervical Nodal Metastasis

Tuesday, Nov. 28 11:20AM - 11:30AM Room: N229

Participants
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PURPOSE

To evaluate a novel prediction model using dual energy CT (DECT) multi-energy texture feature analysis of head and neck squamous cell carcinoma (HNSCC) tumors to (1) predict the presence of associated cervical lymphadenopathy and (2) compare the accuracy of multi-energy versus single energy (65 keV) texture evaluation for endpoint prediction.

METHOD AND MATERIALS

87 patients with HNSCC having undergone a DECT scan of the neck were included in this study (64 untreated, 23 recurrent tumors). Texture analysis was performed using a commercial software (TexRAD®) by manually delineating a region of interest around the largest diameter of the tumor. Analysis and texture feature extraction was then performed on virtual monochromatic images (VMIs) ranging from 40 to 140 keV in 5 keV increments or VMIs at 65 keV alone. Random forests (RF) models were constructed using various histogram-based texture features for outcome prediction with internal cross-validation in addition to use of separate randomly selected training (70%) and validation (30%) sets. Sensitivity (Sens), specificity (Spec), positive predictive value (PPV), and negative predictive value (NPV) were determined for predicting positive versus negative nodal status in the neck.

RESULTS

When the entire patient population was evaluated, multi-energy texture analysis could predict the nodal status with an estimated Sens, Spec, PPV, and NPV of 77%, 75%, 77%, and 75%, respectively. Texture evaluation of VMIs at 65 keV only had a lower accuracy, with an estimated Sens, Spec, PPV, and NPV of 69%, 50%, 60%, and 60%, respectively. When the subset of untreated cases was evaluated, Sens, Spec, PPV, and NPV was 100%, 56%, 71%, and 100% using multi-energy analysis.

CONCLUSION

Multi-energy DECT texture analysis of HNSCC tumor is superior to texture analysis of single energy image sets at 65 keV alone and can be used to predict the nodal status in the neck with relatively good accuracy, providing information not currently available by routine clinical evaluation of the primary tumor.

CLINICAL RELEVANCE/APPLICATION

DECT texture analysis of the HNSCC tumor incorporated into radiomic models has the potential to predict neck nodal status with sufficient accuracy to preclude elective neck dissection in some cases.

SSG11-07 Advancing Precision Imaging of the Orbits with Higher Definition Digital PET/CT

Tuesday, Nov. 28 11:30AM - 11:40AM Room: N229

Participants
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PURPOSE

The purpose of this study is to assess the clinical potential of digital photon counting PET (dPET) detector technology to enable higher definition imaging of the orbit and its associated structures and compare its imaging characteristics to conventional photomultiplier tube-based detector PET (cPET).

METHOD AND MATERIALS

Twenty oncology patients with no known orbital malignant or metastatic involvement agreed to participate in an ongoing intra-individual comparison of FDG PET imaging using pre-commercial release dPET/CT (Vereos) and cPET/CT (Gemini TF 64) systems. Standard whole-body cPET was performed using a target dose of 481 MBq FDG and imaged at ~75 min p.i. and investigational dPET was performed either at ~55 min or ~95 min p.i. Conventional PET and dPET images were reconstructed using voxel volumes of 4

mm3 (standard definition). Digital PET images were also reconstructed with smaller voxel volumes of 2 mm3 (high definition) and 1 mm3 (ultra-high definition). Intra-individual comparison of cPET/CT and dPET/CT image characteristics as well as overall image quality was performed by a blinded reader panel.

RESULTS

All 20 cPET and 60 dPET data sets were evaluable. No FDG-avid pathologic orbital lesions were identified. There was improved image quality with higher definition dPET/CT. Ultra-high definition dPET/CT images were rated best and enabled better delineation of the orbital soft tissue structures. Quantification of physiologic FDG uptake in orbital structures using higher definition dPET demonstrated slightly increasing SUVmax values which likely relate to the reduction in partial volume.

CONCLUSION

There exists an unmet clinical need to improve visualization and characterization of orbital soft tissue structures on FDG PET. Even with whole-body acquisitions, higher definition dPET/CT enables better visualization and characterization of normal orbital structures when compared with standard definition cPET/CT.

CLINICAL RELEVANCE/APPLICATION

Higher definition digital PET improves image quality and better delineates orbital structures which may allow for better lesion detectability especially for small, metabolically active lesions.

SSG11-08 Relationship between MRI and Optical Coherence Tomography (OCT) Measurements in Patients with Optic Nerve Atrophy

Tuesday, Nov. 28 11:40AM - 11:50AM Room: N229

Participants
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PURPOSE

The purpose of this study was to: (1) Assess the relationship between MRI measurements of optic nerve (ON) area and OCT measurement of retinal nerve fiber layer (RNFL) thickness, and (2) Determine a threshold ON area which predicts clinical diagnosis of optic nerve atrophy.

METHOD AND MATERIALS

Twenty-six patients with suspected optic nerve atrophy (unilateral = 13; bilateral =13) who also had both an orbital MRI and an OCT study were retrospectively evaluated. An additional thirty-five patients who had received prior MR imaging (without OCT measurements) as part of a seizure protocol, and who had no listed ocular diagnoses, were included as controls. Age data was included and controls were selected to have an age distribution similar to case subjects. Coronal inversion-recovery images of orbital MRI were used to determine ON area at mid orbital level. RNFL thickness was determined on a Heidelberg Engineering Spectralis SD-OCT machine. Each eye was treated as a separate data point. Correlation coefficients were used to evaluate relationships, Mann-Whitney test to compare measurements, and ROC to investigate predictive accuracy.

RESULTS

No significant relationship between ON area and age was detected. A significant relationship was found between MRI measurements of ON area and OCT measurements of RNFL thickness ($r=0.61$; $p < 0.001$). There was a significant difference in ON area between subjects with optic nerve atrophy (3.5 ± 1.9 mm2; Mean ± SD) and controls (7.2 ± 2.8 mm2; $p < 0.001$). Selecting a threshold MRI-measured ON area of 4.4 mm2 had a sensitivity of 0.89 and a specificity of 0.91. The area under the ROC curve was 0.94.

CONCLUSION

MRI measurements of ON area correlate significantly with RNFL thickness measured by OCT. Our data also suggest that MRI-measured ON area < 4.4 mm2 has high sensitivity and specificity for predicting the presence of optic nerve atrophy, making it a potential diagnostic tool for radiologists.

CLINICAL RELEVANCE/APPLICATION

MRI measurement of optic nerve area can be used to predict the presence of optic nerve atrophy, making it a potential diagnostic tool for radiologists.

SSG11-09 Predictive Values of ASQ Imaging in Predicting Hypothyroidism in Hashimoto's Thyroiditis

Tuesday, Nov. 28 11:50AM - 12:00PM Room: N229

Participants
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PURPOSE

ASQ (acoustic structure quantification) can provide objective and quantitative analysis of thyroid echogenicity. Our aim is to

investigate the clinical significance of ASQ imaging parameters whether it can predict progression of hypothyroidism in Hashimoto's thyroiditis (HT).

METHOD AND MATERIALS

We prospectively enrolled 92 lobes in 50 patients with HT who underwent ASQ imaging with 3 year follow up. Initial and 3 year follow up ASQ parameters including AV mode, AV average, AV SD, AV ratio, blue mode, blue average, blue SD and clinical data including thyroid function test were collected. Clinical and ASQ parameters were analyzed as possible predictors of hypothyroidism.

RESULTS

Patients who developed hypothyroidism showed lower AV mode (P=.003), lower AV average (P=.039), lower blue average (P=.02) and lower blue SD (P=.025) than patients with no change or improved thyroid function. Lower AV blue mode value (OR 0.98, P=.0019) and larger changes in AV ratio (OR 1.06, P=.0297) were significantly associated with hypothyroidism in HT.

CONCLUSION

Patients who progressed to hypothyroidism showed lower ASQ values at initial presentation. Initial ASQ parameters might be useful in stratifying the risk of hypothyroidism progression in patients with HT.

CLINICAL RELEVANCE/APPLICATION

ASQ imaging may be helpful for identifying patients at high risk for progression of hypothyroidism in HT.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSG12

Neuroradiology (Slow and Steady: Understanding Movement Disorders)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: N227B

NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Rihan Khan, MD, Tucson, AZ (*Moderator*) Nothing to Disclose
David R. De Lone, MD, Rochester, MN (*Moderator*) Nothing to Disclose

Sub-Events

SSG12-01 Clinical Indication and Impact on Management of DaTscan (Ioflupane I-123) SPECT/CT in Patients with Suspected Parkinsonian Disease

Tuesday, Nov. 28 10:30AM - 10:40AM Room: N227B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

An accurate diagnosis is of importance for a timely and appropriate therapeutic management of patients with clinically uncertain parkinsonian syndromes (CUPS). We aim to evaluate the clinical impact of DaTscan (I-123 Ioflupane) on diagnosis and therapeutic management.

METHOD AND MATERIALS

This is a retrospective study including patients seen at a Movement Disorder Center between January 2005 and January 2015. The main inclusion criteria was a pre-test clinical diagnosis of CUPS. All studies were performed after injection of 3-5mCi I123-Ioflupane followed by SPECT imaging of the head 3-4 hours after injection using a gamma camera equipped with low energy high resolution collimators. Patients demographic data, medications at the time of the study, relevant laboratory tests, diagnosis before and after the test and change in management after the study were reviewed.

RESULTS

203 (85 male, 118 female; median age 64 years) patients diagnosed with CUPS were included in the study. In 152 patients, a diagnosis prior to and after the scan was available. In 180 patients, medication history during the time of the study was available. At baseline, the most common diagnosis was Parkinson's disease (77/152; 50.7%), followed by essential tremor (37/152; 24.3%) and parkinsonism (26/152; 17.1%). In majority of the patients (163/180; 90.6%), medications that affect radiotracer binding were withdrawn per protocol prior to the study. In 10.4% patients, in whom the medications were not withdrawn, the radiotracer binding pattern was qualitatively reviewed. The DaTscan let to a change in diagnosis in 79/152 (51.9%) patients. In 68/139 (48.9%) patients, there was certain impact in therapeutic management. The most frequent change in clinical management was initiation of a new medication not planned at baseline. DaTscan was safe and well tolerated with no reported adverse events.

CONCLUSION

I-123 Ioflupane SPECT of the brain performed for evaluation of patients with suspected parkinsonian syndromes lead to change in diagnosis in 51.9% patients and change in management in 48.9% patients and appears to be a powerful tool in supporting movement disorder specialists in clinical decision making.

CLINICAL RELEVANCE/APPLICATION

DaTscan is a powerful tool in the current clinical diagnosis and management of patients with suspected parkinsonian disease

SSG12-02 Deep Cerebral Venous Oxygenation Content in Patients with Parkinson's Disease Using Quantitative Susceptibility Mapping

Tuesday, Nov. 28 10:40AM - 10:50AM Room: N227B

Participants
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PURPOSE

To evaluate the deep brain venous blood oxygen content changes in patients with Parkinson's disease using Quantitative Susceptibility Mapping (QSM), and to explore the ability of QSM in reflecting the clinical condition.

METHOD AND MATERIALS

This prospective study approved by the hospital ethics committee. Twenty PD patients enrolled in the study. All the clinical-proved patients fulfilled the UK Parkinson's disease Brain Bank Criteria for the diagnosis of idiopathic PD underwent conventional MRI and QSM scan. All the patients' clinical conditions quantified according to the Montreal Cognitive Assessment (MoCA) and Hoehn-Yahr grading scale. The score was 14-30 and 1-3. Twenty age and gender matched healthy controls underwent conventional MRI and QSM scan and the clinical data were collected. The blood oxygen content of deep brain vein were estimated by the susceptibility value, different susceptibility value of blood vessels and surrounding tissues were processed with SPIN software, recording as Δ(S). The blood vessels consist of bilateral Basal Vein (BV), Superficial Middle Cerebral Veins (SMCV), Internal Cerebral Vein (ICV), and Superior Thalamostriate Vein (STV). The difference of Δ(S) of each vein between PD group and healthy control group compared using independent sample t-test. The correlation between Δ(S) and clinical condition (MoCA and Hoehn-Yahr scales) tested using Spearmans correlation.

RESULTS

1. The different susceptibility value Δ(S) of BV, SMCV, ICV, and STV were higher in PD patients than the controls ($t=2.165, 2.300, 2.105$, $P<0.05$). 2. The Δ(S) of BV and STV had significant positive correlation with MoCA scores($r=0.625, 0.632$,$P<0.01$).

CONCLUSION

The state of hypoxia of the brain parenchyma appears in PD patients. The extent of hypoxia can reflect the disability of the patients.

CLINICAL RELEVANCE/APPLICATION

Quantitative Susceptibility Mapping (QSM) can reflect the venous blood oxygen content changes via susceptibility change of different tissues.

SSG12-03 Imaging Findings on MR Guided Focused Ultrasound Thalamotomy for Tremor

Tuesday, Nov. 28 10:50AM - 11:00AM Room: N227B

Participants
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PURPOSE

Thalamotomy of the ventral intermediate nucleus (VIM) is effective in alleviating medication resistant tremor in patients with essential tremor (ET) and Parkinson's disease (PD). MRI guided focused ultrasound (MRgFUS) is an innovative technology that enables noninvasive thalamotomy via thermal ablation. In this presentation we show the imaging finding post MRgFUS, in a cohort of 32 patients.

METHOD AND MATERIALS

Patients with severe medication resistant tremor underwent unilateral VIM thalamotomy using MRgFUS. MRI studies were obtained at the day of treatment, 1 day post treatment, 1 week, 2-3 months and at 1 year post treatment. MRI studies included high resolution T2 images in addition to routine contrast enhanced study. Images were retrospectively analyzed for lesion size and imaging characterization. Patients were also evaluated for tremor alleviation and quality of life.

RESULTS

MRgFUS resulted in close to a spherical lesion in the planned target with a diameter of 4-9 mm (average, 6.8 ± 1.5mm), surrounded by mild edema at 1 post procedural day with increased edema one week after the procedure. The edema lasted for 5-8 weeks following the procedure. On DWI the lesion had diffusion restriction immediately post treatment, which lasted up to 2 months. The central aspect of the lesion had low SWI signal that started at 1day post treatment. Peripheral enhancement appeared usually at 2 months post treatment. At 3 months the lesion decreased in size and the edema resolved, and at 1 year follow-up the lesion was sometimes difficult to depict, with no correlation of the residual lesion size or imaging characteristics to the sustained tremor relief.

CONCLUSION

MRgFUS resulted in a lesion at the planned target. The lesion undergoes expected imaging changes with initial increase in edema and later resolution. So far there are no imaging characteristics that depict response to treatment.

CLINICAL RELEVANCE/APPLICATION

On MRI there are expected imaging changes following MRgFUS.

SSG12-04 Inhibitory Motor Dysfunction in Parkinson's disease Subtypes

Tuesday, Nov. 28 11:00AM - 11:10AM Room: N227B

Participants
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PURPOSE

Parkinson's disease (PD) is divided into postural instability gait difficulty (PIGD) and tremor-dominant (TD) subtypes. Increasing evidence has suggested that the GABAergic neurotransmitter system is involved in the pathogenesis of PD; however, to-date, MRS of GABA in both subtypes has not been performed. Thus, the aim of this study was to evaluate the differences of GABA levels between PD motor subtypes using MEGA-PRESS.

METHOD AND MATERIALS

PD patients were classified into PIGD (n = 13) and TD groups (n = 9); sixteen age- and gender- matched healthy controls were recruited. All subjects were right-handed and underwent MRS scan including MEGA-PRESS. GABA+ levels and Creatine (Cr) levels were quantified in the left basal ganglia (BG). Differences in GABA+ levels among three groups were analyzed using analysis of covariance. The relationship between GABA levels and unified Parkinson's disease rating scale (UPDRS) was also analyzed.

RESULTS

GABA+ levels were significantly lower in left BG regions of PD patients compared with healthy controls ($p < 0.001$). In PD patients, the GABA concentration was lower in the TD group than PIGD group ($p = 0.025$). Cr levels in PIGD and TD were lower than controls ($p = 0.006$; $p = 0.001$). A significant negative correlation was found in PIGD between GABA levels and UPDRS ($r = -0.586$, $p = 0.035$), while no correlation was found in TD.

CONCLUSION

Low BG GABA levels in PD patients, and differences between PIGD/TD patients, suggest that GABAergic dysfunction may play an important role in the pathogenesis of Parkinson's disease.

CLINICAL RELEVANCE/APPLICATION

Low BG GABA+ levels in PD patients, and differences between PIGD/TD patients, suggest that GABAergic dysfunction may play an important role in the pathogenesis of Parkinson's disease.

SSG12-05 Surface-Based Morphometry and Tractography in Patients with Parkinson's disease and Freezing of Gait

Tuesday, Nov. 28 11:10AM - 11:20AM Room: N227B

Awards
Student Travel Stipend Award

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PURPOSE

Freezing of Gait (FOG) is a disabling gait disturbance, consisting in a transient inability to initiate or maintain stepping, often experienced by patients with Parkinson's Disease (PD). Although recent Magnetic Resonance Imaging (MRI) studies underlined the involvement of certain brain areas in FOG patients, there is still lack of agreement between authors. Our purpose was to study structural Gray Matter (GM) and White Matter (WM) changes in PD patients with FOG.

METHOD AND MATERIALS

We studied 21 PD patients with FOG, 16 PD patients without FOG (nFOG) and 19 healthy subjects (HS). Patients were evaluated with clinical scales assessing for motor and cognitive functions. Participants underwent a standardized 3T MRI protocol (Siemens, Verio). For gray matter evaluation, Cortical volume (CV), Cortical thickness (CTh), and Surface Area (SA) were obtained by an automated surface-based analysis of T1-3D images using FreeSurfer pipeline. For white matter evaluation, DTI images were analyzed using Tracts Constrained by Underlying Anatomy (TRACULA) in FreeSurfer.

RESULTS

No differences in demographic and clinical characteristics were found between FOG and noFOG patient groups. FOG patients exhibited a significant reductions in CTh in the mesial surface of both the hemispheres (superior frontal gyrus, paracentral lobule, posterior cingulate areas, precuneus, pericalcarine cortex) and in the right dorsolateral prefrontal cortex, compared to HS. FOG patients showed smaller SA in the right supramarginal and superior parietal areas than nFOG. WM changes were observed in FOG patients in the temporal bundle of the superior longitudinal fasciculus, uncinate fasciculus and cingulum cingulate gyrus (mostly in the right hemisphere) and in the frontal radiation of the corpus callosum. DTI abnormalities in most of these white matter bundles significantly correlated with cognitive scores.

CONCLUSION

FOG may result from disruption of integration processes rather than from damage of a single area. GM changes in mesial frontal-parieto-occipital cortex are associated to WM changes of long-range associative fibers that allow both inter- and intra-hemispheric integration.

CLINICAL RELEVANCE/APPLICATION

Deterioration of multiple brain structures involved in high-level gait control, and loss of integration between motor, cognitive and limbic information may constitute the anatomical substrate of freezing of gait in Parkinson's disease.

SSG12-06 Longitudinal Diffusion Tensor Imaging as a Predictor of Motor Impairment Worsening in Early Stage Parkinson's Disease

Tuesday, Nov. 28 11:20AM - 11:30AM Room: N227B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To verify whether white matter microstructural changes are predictors of declining motor impairment in Parkinson's disease (PD).

METHOD AND MATERIALS

A total of 123 patients with early PD were enrolled along with 49 controls. Participants underwent clinical, motor (Movement Disorder Society Unified Parkinson's Disease Rating Scale Part III) and 3T MRI DTI investigations at baseline and 18 month evaluation. Baseline and longitudinal fractional anisotropy (FA) and mean diffusivity (MD) changes were analysed voxelwise using Tract Based Spatial Statistics in generalised linear models. Imaging parameters were analysed using Tract Based Spatial Statistics. The relationships between fractional anisotropy (FA) and mean diffusivity (MD) with motor function were investigated using multiple linear regression. All analyses were controlled for age, sex, disease duration, levodopa dose and visit intervals.

RESULTS

At baseline, patients with PD had significantly higher widespread MD than controls. At follow-up, both groups showed a further significant FA decrease and MD increase. Baseline MD was a significant predictor of worsening of motor impairment in PD (B (95%CI) 61.07 (15.75; 106.40), p 0.009), whereas FA was not a significant predictor (B (95%CI) -76.55 (-158.42; 5.32), p 0.067).

CONCLUSION

MD represents an important correlate and predictor of motor impairment in PD: DTI is potentially a useful tool in stratification of patients into clinical trials and to monitor the impact of treatment on motor function.

CLINICAL RELEVANCE/APPLICATION

This prospective longitudinal large cohort, demonstrated that mean diffusivity is a predictor of future worsening of motor function in early Parkinson's disease. Diffusion tensor imaging is potentially a useful tool in stratification of patients into clinical trials to monitor the impact of treatment on motor function.

SSG12-07 Assessment of Patients Who Presented with Parkinsonism: Nigrosome-1 Susceptibility Map-weighted Imaging versus 18F-FP-CIT PET

Tuesday, Nov. 28 11:30AM - 11:40AM Room: N227B

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PURPOSE

Normal presynaptic dopaminergic function is one of the diagnostic exclusion criteria for idiopathic Parkinson's disease (IPD). Nigrosome-1 imaging can reflect the status of substantia nigra pars compacta (SNpc). As susceptibility map-weighted imaging (SMWI) has a higher contrast-to-noise ratio than conventional susceptibility-weighted imaging, it can be hypothesized that nigrosome-1 SMWI may show comparable diagnostic performance with 18F-FP-CIT PET (CIT PET). We sought to compare nigrosome-1 SMWI with CIT PET for assessing patients who presented with parkinsonism.

METHOD AND MATERIALS

We prospectively obtained both SMWI and CIT PET in 206 patients who presented with parkinsonism and in 16 healthy subjects. All participants underwent oblique axial 0.5×0.5×1.0-mm3 6-echo gradient-recalled echo covering the SNpc at 3T. The reconstructed quantitative susceptibility mapping was used to generate SMWI. Each side of nigrosome-1 was retrospectively assessed by 2 independent reviewers. Discrepancy was resolved by consensus. Each side of the basal ganglia on CIT PET was assessed by a nuclear medicine specialist, which served as a reference standard. Participants with abnormality in either side of the basal ganglia on CIT PET or the nigrosome-1 on SMWI were considered having disease.

RESULTS

Patients were diagnosed as IPD (n = 98), drug-induced parkinsonism (n = 65), MSA-C (n = 10), MSA-P (n = 7), essential tremor (n = 7), PSP (n = 3), and others (n = 13) based on both clinical and imaging findings. Interrater agreement for SMWI was excellent (k = 0.973). As for 444 basal ganglia interpretations on CIT PET, SMWI showed 11 false-positive (FP) and 11 false-negative (FN) interpretations (sensitivity [SE], specificity [SP], positive-predictive value [PPV], and negative-predictive value [NPV] were 94.9%, 95.2%, 94.9%, and 95.2%), showing no significant difference (P = 1.0, McNemar test). As for 222 participants, SMWI demonstrated 7 FP interpretations without FN readings (SE, SP, PPV, and NPV were 100%, 93.7%, 94.1%, and 100%) (P = 0.016, McNemar test).

CONCLUSION

Presynaptic dopaminergic function on 18F-FP-CIT PET can be comparably assessed on SMWI in patients who presented with parkinsonism.

CLINICAL RELEVANCE/APPLICATION

Compared to CIT PET, SMWI has similar diagnostic performance without FN readings, and can serve as a screening imaging tool for patients who need further evaluation by dopamine transporter imaging.

SSG12-08 Clinical Application of Quantifying Changes in Nigrosomes in the Diagnosis of Early-Stage Parkinson's Disease

Tuesday, Nov. 28 11:40AM - 11:50AM Room: N227B

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PURPOSE

For diagnosing Parkinson's disease (PD), decreased dopaminergic neuron in the nigrosomes which are primary subregions of the substantia nigra pars compacta (SNpc), and increased iron deposition in the nigrosome 1 which is the largest nigrosome subgroup and located in the dorsolateral SNpc have been assessed. Our aim was to assess the utility of quantifying these neurodegenerative changes in the SNpc in the diagnosis of early-stage PD.

METHOD AND MATERIALS

Eighteen patients (PD group) with early PD stages (Hoehn and Yahr scale: 1-2) and 18 age-matched healthy controls (HC group) underwent quantitative susceptibility mapping (QSM), neuromelanin imaging and three-dimensional (3D) T1W imaging on a 3T magnetic resonance imager. Both QSM and neuromelanin values of the SNpc were calculated using a region of interest (ROI) based automated segmentation system with the voxel-based morphometric technique. Two respective ROIs encompassing the whole and dorsolateral SNpc were created (Figure). Signal to noise ratio (SNR) of the SNpc in the neuromelanin images was calculated on the basis of mean value of the automatically segmented background region. In both ROIs, the significance of intergroup differences in each median QSM value and neuromelanin area of higher SNR than that of the background region were tested using Mann-Whitney's U test. Logit (p) was used to estimate the probability of PD in relation to the QSM value and the neuromelanin area, and the diagnostic performances of each value of the ROIs and logit (p) were assessed using Receiver operating characteristic (ROC) analysis.

RESULTS

In both ROIs, QSM value was significantly higher, and neuromelanin area was significantly less, in PD group than in HC group ($P < 0.05$). The respective areas under the ROC curve for QSM value/neuromelanin area were 0.70/0.81 for the whole SNpc ROI and 0.73/0.78 for the dorsolateral SNpc ROI, and that for logit (p) in relation to QSM value of the dorsolateral SNpc ROI and neuromelanin area of the whole SNpc ROI was 0.86.

CONCLUSION

Comprehensive MRI assessment for the abnormality involving the nigrosomes can yield a high diagnostic accuracy for early PD.

CLINICAL RELEVANCE/APPLICATION

Quantifying the dopaminergic neurodegenerative changes with iron deposition, featuring spatial difference of nigral changes in the SNpc, can provide a high diagnostic accuracy for early PD.

SSG12-09 Response to Deep Brain Stimulation is Associated with Increased Resting State Connectivity in the Associative Basal Ganglia Circuit

Tuesday, Nov. 28 11:50AM - 12:00PM Room: N227B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Deep brain stimulation (DBS) of the subthalamic nucleus (STN) or globus pallidus pars interna (GPi) is indicated in patients with refractory Parkinson's disease (PD) with significant motor fluctuations. While clinical characteristics facilitate patient selection, no objective tool to predict response to DBS exists. We examined resting state functional magnetic resonance imaging (rsfMRI) to determine the feasibility of this modality to serve as such a predictive tool.

METHOD AND MATERIALS

Eight patients (3 female) with advanced PD underwent a preoperative MRI under anesthesia in preparation for DBS surgery. Motor scores (UPDRS-III) were collected before and after DBS (mean follow-up of 5.9 months). Scans were performed in a 3T Achieva Philips MR scanner, including rsfMRI (TR=2000ms, TE=25ms, FOV=68×68mm, flip angle=90o, spatial resolution=1.87×1.87×3.5mm, matrix size=128×128). Images were preprocessed to correct for spatial and temporal artifacts. Regions of interest (ROIs) were defined using the Harvard-Oxford atlas and the ATAG-MNI04 basal ganglia atlas. Functional connectivity (FC) was calculated using the MatLab-based CONN toolbox via two-tailed bivariate correlations. Significant FC differences between patients who had improved UPDRS-III scores following DBS versus those who had worse UPDRS-III scores following DBS were evaluated with both a ROI-to-voxel and ROI-to-ROI analysis (FDR-corrected $p<0.05$).

RESULTS

Patients were 66.5±8.9 years old with disease duration of 7.3±1.8 years. Preoperative UPDRS-III was 29.3±10.6 and postoperative UPDRS-III was 21.9±9.0. Patients who responded more favorably to DBS had increased resting state connectivity within the basal ganglia (STN, pallidum, thalamus, striatum) and increased connectivity between the striatum and the frontal operculum ($p=0.001$).

CONCLUSION

Three major basal ganglia networks consisting of motor, associative, and limbic circuits have been described. While much focus has been on motor circuits in PD, our findings suggest that the associative circuit may play a role in DBS response and show promise in the ability for rsfMRI to provide better pre-surgical consultation to patients regarding prognosis from DBS.

CLINICAL RELEVANCE/APPLICATION

Together, these results show promise in the ability for rsfMRI to provide better pre-surgical consultation and guidance to patients regarding prognosis from DBS.

RSNA 2017 Explore. Invent. Transform.
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SSG13

Physics (CAD and Machine Learning)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S404AB

BQ CT IN PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSG13-01 Observer Performance Study for Bladder Cancer Treatment Response Assessment in CT Urography With and Without Computerized Decision Support

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S404AB

Participants
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PURPOSE

To evaluate whether a computerized decision support system for bladder cancer treatment response assessment (CDSS-T) can assist radiologists in identifying patients who have complete response after neoadjuvant chemotherapy.

METHOD AND MATERIALS

With IRB approval, pre- and post-chemotherapy CTU scans of 123 patients were collected retrospectively, resulting in 158 pre- and post-treatment lesion pairs. The pathological cancer stage after treatment, as determined by cystectomy, was collected as the reference standard of whether a patient fully responded to treatment. Twenty-five percent of the lesion pairs (40/158) had T0 cancer stage after chemotherapy, which corresponds to a complete response. We have developed a CDSS-T system that uses a combination of DL-CNN and radiomics features to distinguish between cases that have fully responded to treatment and those that have not. Two abdominal radiologists and 4 residents trained in abdominal radiology estimated the likelihood of stage T0 disease after treatment by viewing each pre-post-treatment CTU pair displayed side by side on a specialized graphic user interface designed for CDSS-T. The observer provided an estimate without CDSS-T first and then might revise the estimate, if preferred, after the CDSS-T score was displayed. The cases were randomized differently for each observer. The observers' estimates with and without CDSS-T were analyzed with multi-reader, multi-case (MRMC) receiver operating characteristic (ROC) methodology. The area under the curve (AUC) and the statistical significance of the difference were calculated.

RESULTS

The AUC for prediction of T0 disease after treatment was 0.80±0.04 for the CDSS-T alone. Each observer's performance increased with the aid of CDSS-T. The average AUC for the observers were 0.75 (range: 0.70-0.79) without CDSS-T, and increased to 0.78 (range: 0.73-0.81) with CDSS-T. The differences in the average AUC values between without CDSS-T and with CDSS-T were statistically significant ($p < 0.01$).

CONCLUSION

Our study demonstrated that our CDSS-T system for bladder cancer treatment response assessment in CTU can improve radiologists' performance in identifying patients who fully responds to treatment.

CLINICAL RELEVANCE/APPLICATION

CDSS-T has the potential to improve radiologists' accuracy in bladder cancer treatment response assessment, which is vital for identifying non-responders and allowing them to seek alternative therapy.

SSG13-02 DeepBreath: Automated Lung Nodule Detection and Segmentation with Convolutional Neural Networks

Tuesday, Nov. 28 10:40AM - 10:50AM Room: S404AB

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PURPOSE

To automatically detect and segment lung nodules in Computed Tomography (CT) scans for computer-aided detection of lung cancer

METHOD AND MATERIALS

Following the LUng Nodule Analysis (LUNA) 2016 challenge, our dataset contains 888 CT scans from Lung Image Database Consortium (LIDC) with slice thickness <= 3mm. There are 1,186 nodules in which the median diameter is 6.43mm (min=3.25mm, max=32.27mm). We designate 80% of the scans as training set, 10% as validation set and 10% as test set. We report all metrics on the test set. Our approach consists of the following three stages: First, we use a 2D U-Net-based segmentation proposal network to suggest initial nodule candidates for each scan. We apply higher weight to the loss in the center of the nodules with gradual drop-off towards the edges to encourage the network to learn the nodule center and boundary. Next, we use a 2.5D ResNet-based classifier to reduce the number of false positives (FP). We extract 9 views (6 diagonal and 3 orthogonal) for each candidate and oversample positive nodules to account for label imbalance. Finally, we segment positive nodules with a 3D U-Net based network to obtain fine-grained nodule masks. The network is trained on 3D patches centered on the nodule with ground truth masks based on agreement of three of the four LIDC annotators. We evaluated our method using nodule recall at 2 FP per scan and nodule recall from the proposal network. For nodule segmentation, we report the dice coefficient between ground truth and prediction segmentation.

RESULTS

In the first stage, the proposal network has a recall of 92.04% with an average of 969.34 FP/scan. By ensembling two proposal networks, we achieve a recall of 95.57% with 1161.24 FP/scan. After the classifier stage, the number of FP has been reduced by 500x to 2 FP/scan while maintaining a high recall of 85.86%, 95% CI [75.01% and 92.67%]. For nodule segmentation, the mean volumetric dice coefficient is 0.76 ± 0.14.

CONCLUSION

Our automated nodule detection method yields a high nodule recall rate while maintaining a low false positive rate. Furthermore, our nodule segmentation method provides accurate and detailed nodule segmentation in 3D to assist clinical management and follow-up.

CLINICAL RELEVANCE/APPLICATION

A reliable lung CADe system may become essential for detection of lung lesions for early diagnosis of cancer. It may improve radiologist accuracy and efficiency as a second reader.

SSG13-03 Direct Coronary Artery Calcium Scoring in Low-Dose Chest CT Using Deep Learning Analysis

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S404AB

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PURPOSE

Coronary artery calcium (CAC) score determined in screening with low-dose chest CT is a strong and independent predictor of cardiovascular events (CVE). However, manual CAC scoring in these images is cumbersome. Existing automatic methods detect CAC lesions and thereafter quantify them. However, precise localization of lesions may not be needed to facilitate identification of subjects at risk of CVE. Hence, we have developed a deep learning system for fully automatic, real-time and direct calcium scoring circumventing the need for intermediate detection of CAC lesions.

METHOD AND MATERIALS

The study included a set of 1,546 baseline CT scans from the National Lung Screening Trial. Three experts defined the reference standard by manually identifying CAC lesions that were subsequently quantified using the Agatston score. The designed convolutional neural network analyzed axial slices and predicted the corresponding Agatston score. Per-subject Agatston scores

were determined as the sum of per-slice scores. Each subject was assigned to one of five cardiovascular risk categories (Agatston score: 0, 1-10, 10-100, 100-400, >400). The system was trained with 75% of the scans and tested with the remaining 25%. Correlation between manual and automatic CAC scores was determined using the intra class correlation coefficient (ICC). Agreement of CVD risk categorization was evaluated using accuracy and Cohen's linearly weighted κ.

RESULTS

In the 386 test subjects, the median (Q1-Q3) reference Agatston score was 54 (1-321). By the reference, 95, 37, 86, 94 and 75 subjects were assigned to 0, 1-10, 10-100, 100-400, >400 risk categories, respectively. The ICC between the automatic and reference scores was 0.95. The method assigned 85% of subjects to the correct risk category with a κ of 0.90. The score was determined in <2 seconds per CT.

CONCLUSION

Unlike previous automatic CAC scoring methods, the proposed method allows for quantification of coronary calcium burden without the need for intermediate identification or segmentation of separate CAC lesions. The system is robust and performs analysis in real-time.

CLINICAL RELEVANCE/APPLICATION

The proposed method may allow real-time identification of subjects at risk of a CVE undergoing CT-based lung cancer screening without the need for intermediate segmentation of coronary calcifications.

SSG13-04 Investigating the Depth of Convolutional Neural Networks (CNNs) in Computer-aided Detection and Classification of Focal Lesions: Lung Nodules in Thoracic CT and Colorectal Polyps in CT Colonography

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S404AB

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PURPOSE

In deep learning research in medical image analysis, how deep we should go is an open question. Our purpose was to investigate how the depth of CNNs affects the performance in detection and classification of focal lesions in medical images.

METHOD AND MATERIALS

We collected 3 databases containing (a) 50 lung nodules (4-27 mm) including 38 biopsy-confirmed lung cancers in 32 patients in screening CT for detection of nodules, (b) 28 polyps (5-25 mm) in 146 CT colonography scans in 73 patients for detection of polyps, and (c) 76 biopsy-confirmed malignant nodules and 413 confirmed benign nodules (3-29 mm) in 342 patients in thoracic CT for classification between benign and malignant. We employed CNN architectures with N convolutional and max-pooling layers, a fully-connected layer followed by a soft-max layer. From the 1st to 5th convolutional layer, 11x11, 5x5, 3x3, 3x3, and 4x4 filters (kernels) were used, by following the standard CNN design. We trained and compared 5 CNNs with 5 different depths by reducing the number of convolutional and max-pooling layers. We also changed the number of filters in the convolutional layers from 8, 16, 32, to 64 to investigate the impact of both network depth and width on the performance. We used 5-fold cross validation for training and testing (100 CNNs in total for each database). We evaluated the performance by using receiver-operating-characteristic (ROC) analysis for the classification task and Jackknife alternative free-response ROC (JFROC) analysis for the detection tasks, with the area under the curve as a metric.

RESULTS

There was no statistically significant difference (>.05) among different depth CNNs when 8 or 64 filters were used in the convolutional layers, suggesting that deeper architectures were not effective if CNNs were sufficiently wide. CNNs with 3 or 4 convolutional layers were more effective than shallower architectures, but a further performance gain was not observed by using deeper architectures.

CONCLUSION

Sufficiently wide CNNs with 3 or 4 convolutional layers might be adequate for focal lesion detection and classification in CT. Thus, the use of an unnecessarily deeper deep-learning model would result in inferior performance.

CLINICAL RELEVANCE/APPLICATION

A properly deep deep-learning model would result in higher performance, and such a high-performance computer-aided system would be useful for radiologists in their lesion detection and classification.

SSG13-05 Two Deep-Learning Models for Lung Nodule Detection and Classification in CT: Convolutional Neural Network (CNN) vs Neural Network Convolution (NNC)

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S404AB

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PURPOSE

Deep learning achieved overwhelming success in object classification in computer vision. Our purpose was to develop and compare two classes of deep-learning models in lung nodule detection and classification in CT: CNN models that were imported from the computer vision field vs. NNC that was proposed by us in the medical imaging field.

METHOD AND MATERIALS

We developed, trained, and compared extensively 5 representative CNN models and our NNC model in 1) lung nodule detection and 2) classification in CT. The 5 CNN models were an AlexNet (5 convolution (CL), 3 pooling (PL) and 3 fully-connected layers (FL)), a LeNet (2 CL, 2 PL and 2 FL), a shallow CNN (1 CL, 1 PL and 1 FL), relatively deep CNN (4 CL, 4 PL and 2 FL), and a transfer-learned AlexNet. Our NNC architecture consisted of an ensemble of multiple NNC models, each of which has 3-layer neural network regression (NNR) with a scoring layer, followed by 3 fully-connected layers for classification. Each NNC in the ensemble was trained to classify a specific type of non-nodule from nodules. In NNC, convolution of the NNR was performed to process the entire image, but unlike CNN it was done outside the network. Our databases contained 1) 50 lung nodules including 38 biopsy-confirmed lung cancers from 32 patients in screening CT and 2) 76 biopsy-confirmed malignant nodules and 413 confirmed benign nodules in 342 patients in thoracic CT. We trained and tested the 6 deep-learning models with each of the 2 databases in 5-fold cross validation. We evaluated and compared the performance by using receiver-operating-characteristic (ROC) analysis and free-response ROC analysis.

RESULTS

In 1) nodule detection, our NNC achieved a 100% sensitivity with 2.7 false positives (FPs)/patient, whereas the best performing CNN (transfer-learned AlexNet) generated 22.7 FPs/patient ($P<.05$). In 2) nodule classification, our NNC yielded an area under the ROC curve (AUC) of 0.881 which was significantly ($P<.05$) higher than an AUC of 0.776 for the best performing CNN model.

CONCLUSION

We developed and compared 5 CNN models and our NNC in detection and classification of lung nodules in CT. Our NNC achieved higher performance than the best performing CNN model.

CLINICAL RELEVANCE/APPLICATION

A high-performance deep-learning model would help improve radiologists' diagnostic performance in lung nodule detection and classification in CT.

SSG13-06 Assessing the Performance of CAD in Lung Nodule Detection from Low-Dose Lung Cancer Screening CT Exams Under Different Combinations of Radiation Dose Level, Slice Thickness, and Reconstruction Kernel

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S404AB

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PURPOSE

The goal of this study was to assess the impact of dose reduction and various reconstruction parameters, on the detection of lung nodules by CAD software applied to low dose Lung Cancer Screening CT exams.

METHOD AND MATERIALS

Our dataset consisted of data from 59 subjects who underwent low dose CT for lung cancer screening at our institution. Scans were performed using a 64 slice MDCT with Tube Current Modulation (TCM) according to the AAPM lung cancer screening protocols which yielded a CTDIvol of approximately 2 mGy. For each case, image data and raw projection data were collected. A total of 71 solid nodules larger than 4mm (30 in LungRad1, 25 in LungRAD2, 11 in LungRAD3, 5 in LungRAD4) were identified by radiologists (on original scans with 1mm slice thickness and B45 kernel). Noise was added to the raw projection data to simulate reduced dose scans at 3 dose levels of 10%, 25%, and 50% (corresponding to CTDIvol of 0.2, 0.5 and 1 mGy). All original and simulated raw data were reconstructed with slice thicknesses of 0.6, 1, and 2mm and at three reconstruction kernels (smooth, medium and sharp). Lung regions were segmented using original image data and were mapped to all other image datasets. An in-house CAD software was used to detect nodules on simulated images. Subject level mean sensitivity (in LungRADS categories) and mean false-positive for each of acquisition conditions were calculated.

RESULTS

Subject level mean sensitivity values ranged between 40% to 80% for LungRAD4, 27% to 55% for LungRAD3, 22% to 50% for

LungRAD2, and 10% to 53% for LungRAD1. Sensitivity was stable at all dose levels in LungRAD3 and LungRAD4 categories (even down to 10% of screening dose), with a medium kernel and either 1mm or 0.6 mm slice thickness. Mean false-positive was between 2-9 per patient with most conditions yielding < 4.

CONCLUSION

CAD detection sensitivity was reasonably robust to dose, slice thickness and kernel, though the sharper kernel yielded the most variable performance. False positives were also surprisingly stable except at very high noise (low dose, thin slice, sharp kernel) conditions.

CLINICAL RELEVANCE/APPLICATION

CAD detection of lung nodules in low dose Lung Cancer Screening CT exams may provide assistance to radiologists; the performance may be robust across acquisition and reconstruction conditions.

SSG13-07 Multi-Task Transfer Learning Deep Convolutional Neural Network for Improved Computer-aided Diagnosis of Masses in Mammography

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S404AB

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PURPOSE

A multi-task transfer learning (MTTL) deep convolutional neural network (DCNN) was formulated to translate the 'knowledge' learned from non-medical images to medical imaging 'interpretation' tasks through supervised training and to simultaneously increase the generalization capabilities of DCNNs by learning auxiliary tasks. We compared the MTTL approach to traditional transfer learning method for classification of malignant and benign masses in mammography.

METHOD AND MATERIALS

From the University of South Florida (USF) digitized screen-film mammogram (SFM) database and with IRB approval from the University of Michigan (UM), heterogeneous mammography data sets of SFMs and digital mammograms (DMs) with a total of 2,282 mammograms containing 2,461 lesions were collected. With data augmentation, 19,688 regions-of-interests containing biopsy-proven masses were obtained. Through inductive transfer learning, the objective predictive model from IMAGENET DCNN trained on 1.2 million non-medical images was induced into the target task of classifying masses. In the multi-task learning, the transfer network learned three target tasks (SFM-UM, SFM-USF, DM-UM). In contrast, the single-task learning was trained with a SFM-UM data set alone. Using the training set, a 4-fold case-based cross-validation was performed to select the best training strategy in terms of the depth of convolutional layers that should be frozen during transfer learning. Each experiment was repeated for 10 stochastic initializations to evaluate the robustness of the trained DCNN. An independent test set containing 909 lesions sequestered from SFM-UM was used to assess the difference in performance between the DCNNs trained with single- and multi-task transfer learning by ROC analysis.

RESULTS

Transfer learning by freezing the first convolution layer alone provided the best training. The independent test *AUC* for single- and multi-task transfer learning reached 0.79±0.02 and 0.82±0.02, respectively. The *AUC* difference between the two methods was statistically significant (p-value=0.007).

CONCLUSION

When using transfer learning for DCNNs, multi-task supervised learning achieved better generalization to unknown cases than single-task learning.

CLINICAL RELEVANCE/APPLICATION

The MTTL DCNN framework for classification of masses in mammography has the potential to be extended to digital breast tomosynthesis while utilizing auxiliary tasks from large SFM and DM data sets.

SSG13-08 Deep Learning Analysis for Automatic Calcium Scoring in Routine Chest CT

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S404AB

Participants
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PURPOSE

Coronary artery calcium (CAC) is a robust predictor of cardiovascular events (CVE) in asymptomatic individuals. Several guidelines

recommend reporting of CAC scores in ungated chest CT exams. In addition, chest CT can be used to quantify thoracic aorta calcification (TAC) and cardiac valve calcification (CVC), which may further improve prediction of CVE. This study evaluates the performance of an automatic method for scoring of CAC, TAC and CVC on routine chest CT exams.

CONCLUSION

Fully automatic scoring of coronary, aortic and cardiac valve calcifications highly correlates with manual scoring, even in ungated routine chest CT.

CLINICAL RELEVANCE/APPLICATION

Automatic calcium scoring in routinely acquired ungated chest CT enables identification of subjects at elevated cardiovascular risk without additional reading time.

SSG13-09 Automated Contrast Timing Classification with Deep Convolutional Neural Networks

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S404AB

Participants
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PURPOSE

To investigate whether a machine learning technique known as deep learning, e.g., Deep Convolutional Neural Networks (CNNs), which selects image pixel data directly (rather than utilizing human-designed features) in the extraction of image descriptors, has potential to explore and discover latent imaging features that are difficult to categorize by the human visual system and thus be used in a development of novel imaging biomarkers. We aim to evaluate if machine learning can achieve a classification of the contrast enhancement timing without any human annotation.

METHOD AND MATERIALS

700 CTs acquired at the portal venous phase had their contrast timing determined by a consensus reading between experienced radiologists. Patients were divided between optimal-timing (n=443) vs non-optimal timing (early or late, n=257). These timing data were used as the reference standard for the automated timing classification system. The whole 3D voxel images (normalized to 512*512*150) were used directly as input to a deep learning method (CNNs) to maximally explore the potential imaging features. The proposed network consisted of 5 convolutional layers and LeakyReLU activations, followed by average pooling layers and three dense layers. The outputs were equivalent to the classes: optimal and non-optimal. To train and evaluate the CNN we used a dataset of 700 CTs, within which 600 (396:204) were used as training and validation. The remaining 100 (57:43) were not included in the training set and were thus totally blind to the computer when used for testing. Five-fold cross validation was used to assess performance.

RESULTS

The classification performances were 89.3% (SE:0.01) in the training set and 93.2% (SE:0.01) in the validation set, which demonstrated the potential of CNNs in automatically analyzing contrast enhancement timing classification in CT scans.

CONCLUSION

There is great potential for the application of deep learning methods as an aid to radiologists in the analysis of medical images. Larger datasets with a wider spectrum of timing will be needed to refine performance and the learned imaging features needed to be examined.

CLINICAL RELEVANCE/APPLICATION

An immediate, unbiased appraisal of contrast timing can reduce medical error because certain pathologies are invisible outside of the appropriate contrast phase.

SSG14

Science Session with Keynote: Physics (Breast Tomosynthesis, Breast CT)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S405AB

BR CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Stephen J. Glick, PhD, Silver Spring, MD (*Moderator*) Nothing to Disclose
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Sub-Events

SSG14-01 Physics Keynote Speaker: X-Ray Imaging of the Breast in 3D

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S405AB

Participants
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ABSTRACT

X-ray Imaging of the breast in 3D Prospective clinical trials, retrospective multi-reader studies and observational studies from clinical practices have shown the benefits of digital breast tomosynthesis (DBT), a limited-angle tomographic technique, in breast cancer screening. These include reduced callback rates, particularly reduction in false-positive callbacks, and increased cancer detection rates, particularly for invasive cancers. While DBT continues to be rapidly adopted in clinical practices, studies on further optimization and improvements to DBT continue. In this session, knowledge-gaps in terms of reducing breast compression, system-specific optimization of angular range and angular sampling, model-based iterative reconstruction techniques, methods to monitor system performance using phantoms, and developing a framework for conducting virtual clinical trials to evaluate the potential performance improvements are addressed. Dedicated breast CT is an emerging modality with tremendous potential to be the future of breast imaging addressing numerous clinical needs from screening to surgical planning and monitoring therapy response. It eliminates the need for multiple views with breast compression, as a single scan provides volumetric data with near isotropic spatial resolution that allows viewing the breast in any orientation. It is inherently quantitative and allows for risk estimation by quantifying fibroglandular tissue volume, discriminating malignant and benign lesions by analyzing the enhancement from administered contrast media and quantifying treatment response by monitoring temporal changes in tumor volume.

SSG14-02 Optimized Technique for Reducing Breast Compression in Digital Breast Tomosynthesis

Tuesday, Nov. 28 10:40AM - 10:50AM Room: S405AB

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PURPOSE

Digital breast tomosynthesis (DBT) provides tissue separation superior to mammography, and thus may obviate the need for breast compression, used to reduce breast thickness and consequently improve image quality and reduce mean glandular dose (MGD). Previous attempts to reduce breast compression have either resulted in poorer image quality or increased MGD. We optimized and evaluated an imaging technique for DBT with minimal breast compression without compromising image quality or MGD.

METHOD AND MATERIALS

Imaging technique for a Siemens MAMMOMAT Inspiration DBT system using reduced breast compression (<4 daN) was optimized using a signal-difference-to-noise ratio (SDNR) model accounting for the increase in scattered radiation due to increased breast thickness. Optimal tube potential (kVp) was determined by limiting MGD increase to <10% without decreasing SDNR. The optimized technique was evaluated in an IRB-approved, HIPAA-compliant prospective clinical study, where 21 patients with abnormal mammograms underwent DBT scans using full compression (FC) and minimal compression (MC). Skin markers were affixed to either side of the breast for motion assessment. Two breast radiologists scored lesion conspicuity in the two sets of images using a five-

point scale (-2: full compression much better, to +2: minimal compression much better).

RESULTS

Increasing the tube potential by 2-3 kVp over the FC technique causes no significant change in MGD or image quality. Conspicuity of 26 masses and 6 microcalcification clusters in 21 patients were compared. MGD for FC and MC were not significantly different; patient motion was shown to be comparable. Mass conspicuity was equivalent for FC and MC (mean score = -0.15, bootstrapped 95% CI: -0.38, 0.08); microcalcification conspicuity for MC was noninferior to FC (mean score = -0.17, 95% CI: -0.5, 0). All patients reported MC to be more comfortable than FC.

CONCLUSION

By optimizing imaging technique, breast compression can be reduced to less than half in DBT without sacrificing image quality or increasing MGD. The resulting increase in patient comfort may improve compliance with recommended screening practices.

CLINICAL RELEVANCE/APPLICATION

Breast compression in DBT may be reduced to <4 daN without compromising image quality or dose by optimizing imaging technique, potentially improving patient compliance with screening protocols.

SSG14-03 Design and Application of a Phantom for Testing Tomosynthesis Systems with Particular Emphasis on Automatic Cloud-Based Monitoring

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S405AB

Participants
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PURPOSE

To investigate the possibility of using a newly developed Tomosynthesis Phantom specifically developed for remote monitoring of DBT sites

METHOD AND MATERIALS

A newly developed Tomosynthesis QA Phantom has been developed for testing DBT systems. The phantom is also designed to allow remote analysis via web or cloud. The phantom includes: phantom positioning and alignment (important for remote analysis); scan geometry (x and y); chest wall offset; scan slice width and SSP(z) slice geometry (slice width); scan slice incrementation (z); Z axis geometry bead; low contrast from low contrast spheres; Point Spread Function (PSF); Image uniformity and Contrast to Noise Ratio (CNR). This study shows the success of remotely monitoring this phantom via cloud based uploads of Dicom data to a central processing system.

RESULTS

Results are shown for monitoring each of the parameters as listed in Methods and Materials. Data is shown for all known commercial Tomosynthesis systems. System reproducibility and performance over time, and long term trend analysis are shown. The results show robust and reproducible results. Results are shown for monitoring each of the parameters as listed in Methods and Materials. Data is shown for all known commercial Tomosynthesis systems. System reproducibility and performance over time, and long term trend analysis are shown. The results show robust and reproducible results. The ability to measure phantom position and alignment including roll, yaw, and pitch are found to be important but easily handled by the current software. Data on SSP and in plane resolution (MTF) are found to vary greatly among systems, depending on the DBT design, but amenable to remote monitoring and performance tracking.

CONCLUSION

It is possible to design and utilize phantoms for remote monitoring and performance tracking of Tomosynthesis DBT systems. Slice widths (SSP), and in plane resolution PSF and corresponding MTF although vary greatly among systems depending on the DBT design, are amenable to remote monitoring.

CLINICAL RELEVANCE/APPLICATION

A DBT phantom that is robust in performance measurements, and amenable to remote monitoring, offers clinicians, physicists, and administrators a tool to track the performance of the system.

SSG14-04 Impact of Tomosynthesis Angular Range on Mass Conspicuity in Patients with Dense Breasts

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S405AB

Awards
Student Travel Stipend Award

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PURPOSE

Recent studies have suggested that cancer detection rates for digital breast tomosynthesis (DBT) are poor for patients with heterogeneously to extremely dense breasts. These studies have been predominantly limited to narrow-angle DBT. Increasing angular range (AR) reduces breast structural noise and increases image contrast for masses, potentially improving mass detection in dense breasts. We investigate the effect of AR on mass detectability using a previously validated cascaded linear system model (CLSM) for DBT, and compare theoretical results with clinical findings in an IRB-approved pilot study.

METHOD AND MATERIALS

Mass conspicuity in DBT reconstructions was modeled as a function of AR using a normalized detectability index *d'*, incorporating breast structural noise and image contrast. Under IRB-guidance, DBT images for 6 patients with heterogeneously or extremely dense breasts were compared using both the Hologic Selenia Dimensions DBT system (AR = 15°) and the Siemens MAMMOMAT Inspiration DBT system (AR = 50°). Two breast radiologists were presented with both sets of images for each patient and compared lesion conspicuity on a five-point scale (-2: lesion much more conspicuous on narrow-angle DBT, to +2: lesion much more conspicuous on wide-angle DBT).

RESULTS

Mass detectability was predicted to increase with increasing AR due to reduced structural noise and increased contrast in the reconstructed image slices. Increasing AR from 15° to 50° was predicted to increase detectability of 2, 5 and 10 mm masses by 85.3%, 87.5% and 87.9%, respectively. Clinical findings corroborated simulation results, with mass conspicuity shown to be equivalent or superior for wider-angle DBT, with a mean score of 0.89 (95% CI: 0.44, 1.44). Importantly, masses found in areas with high masking risk (defined as high local density as characterized by the radiologist) were more conspicuous on wider-angle DBT.

CONCLUSION

Using a normalized detectability index *d'*, mass conspicuity was shown to increase with increasing AR. These results were corroborated by a pilot reader study, and motivate a larger clinical study comparing mass conspicuity for differing DBT acquisition geometries.

CLINICAL RELEVANCE/APPLICATION

Tomosynthesis with wider angular ranges may provide mass conspicuity superior to tomosynthesis with narrow-angular range for patients with heterogeneously to extremely dense breasts.

SSG14-05 Reduced Anatomical Noise in Digital Breast Tomosynthesis with Model Based Iterative Reconstruction

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S405AB

Participants
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PURPOSE

The anatomical background of the breast strongly influences mass detection performance in breast imaging. Anatomical noise has previously been quantified using a parameter, ß, which is strongly correlated with mass detection. Reported values of ß in clinical modalities are approximately 3.3 for mammography, 3.2 for digital breast tomosynthesis (DBT), and 2.0 for breast CT. The purpose of this work was to determine whether the anatomical clutter in DBT reconstructions can be reduced using MBIR.

METHOD AND MATERIALS

The anatomical noise power spectrum (NPS) was measured for 105 clinical DBT exams acquired using Hologic Selenia Dimensions systems. A power-law model (NPSa=af-ß) fitting of the anatomical NPS was performed. The exponent, ß, was used as a surrogate for the anatomical noise background and compared between the commercial reconstruction (FBP) and an in-house MBIR method. ß was measured as a function of position within the breast (central 25 slices) and averaged for each breast. The mean measured ß values were compared using a two-tailed t-test (H0:ßComm=ßMBIR) to determine if the difference was statistically significant. The reconstructed images were also assessed subjectively.

RESULTS

The measured ß for the commercial reconstruction method was 3.27±0.40, consistent with previously published values. For the MBIR method, the measured ß value was 2.30±0.55. The reduction in anatomical noise was significant using the MBIR method compared with the commercial method ($p<<0.001$). The variation in ß at different slice locations was negligible in both reconstruction methods. The appearance of anatomical clutter was reduced substantially in reconstructed images as well.

CONCLUSION

MBIR significantly reduced the anatomical noise in DBT reconstructions as quantified using a power-law fitting of the anatomical NPS. The reduction of ß from 3.3 to approximately 2.3 indicates that with MBIR the anatomical noise in DBT is more similar to breast CT than mammography.

CLINICAL RELEVANCE/APPLICATION

Reducing anatomical noise in DBT images with MBIR may improve mass detection for DBT images. This has the potential to improve the sensitivity of treatable cancers for breast screening

SSG14-06 Digital Breast Tomosynthesis as a Replacement of Full-Field Digital Mammography for the Detection of Breast Cancer: An Open-Source, In-Silico Clinical Trial

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S405AB

Participants
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PURPOSE

To determine the comparative performance of digital breast tomosynthesis (DBT) as a replacement to full-field digital mammography (FFDM) using entirely in silico open-source methods and to compare results to previously reported clinical trials. Secondary objectives include measurements of the differential performance in subpopulations and across lesion types.

METHOD AND MATERIALS

Analytic breast phantoms modeling anatomical structures were generated in large numbers corresponding to 4 size and apparent density combinations (from 3.5 to 6 cm compressed thickness and 4 BIRADS density categories) and were compressed using finite-element modeling prior to imaging. Lesions were inserted representing microcalcification clusters and spiculated masses. Phantoms were imaged using a detailed Monte Carlo simulation approach with the GPU-accelerated, freely available MC-GPU code with improved focal spot and tube motion models and thick-layer detector description including fluorescence, anti-scatter grid, and electronic noise. 50-micron voxelized models were simulated using a binary tree geometry and delta-scattering transport. The detection algorithm uses a location-known-exactly paradigm with a channelized Hotelling Observer and spatial frequency filtering for irregular morphology. A small set of readers were trained with distinct training sets of normals and cancers and tested on independent sets. Uncertainty was estimated using a fully-paired multiple-reader, multiple-case analysis. The study was sized to achieve uncertainties lower than those seen in human trials for the differential performance in terms of area-under-the-ROC curve (AUC).

RESULTS

The performance AUC for FFDM during the prepilot stage ranged between 0.87 and 0.96. Sizing of the pivotal trial indicates that 30 computational readers trained on subsets of 100 pairs of cancer and normal regions-of-interest achieve the target uncertainty of approximately 0.01.

CONCLUSION

The findings indicate that the performance seen in in silico trials for FFDM is comparable, under reasonable assumptions, to results obtained in trials using patients and clinicians.

CLINICAL RELEVANCE/APPLICATION

This report describes the first imaging clinical trial performed exclusively using open-source computational methods. Our findings stimulate discussion around increasing the use of computational modeling in the assessment of imaging systems for regulatory evaluation.

SSG14-07 Initial Experimental Results from the First X-Ray Dark Field Breast Tomosynthesis Prototype System

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S405AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

X-ray digital breast tomosynthesis imaging systems have been successfully introduced in current clinical practice. However, the image contrast is limited as it depends on a single contrast mechanism: x-ray absorption. In this work, the first prototype breast tomosynthesis imaging system with both absorption contrast and a new contrast mechanism: dark-field contrast, was constructed and initial experimental results to assess imaging performance are presented.

METHOD AND MATERIALS

The prototype dark field tomosynthesis imaging system was based on a full field digital mammography system (Senographe 2000D,

The prototype dark field tomosynthesis imaging system was based on a full field digital mammography system (Senographe 2000D, GE Healthcare) with a dual-track rotating anode (Rh/Mo) tube and a CsI-based plat panel detector with 100 µm pixel size. Three x-ray gratings were integrated into the mammography system. The dark field tomosynthesis image acquisition was performed using the Grossman geometry, in which the gantry (including both the x-ray tube and detector) rotate around a fixed image object over an arc of 28° (2° interval). The system was operated at 36 kVp/180 mAs with the Rh anode and Rh filter. From a single tomosynthesis acquisition, both dark field and conventional absorption contrast tomosynthesis images were reconstructed using the shift-and-add algorithm; the images have an in-plane pixel size of 70 µm and a slice thickness of 0.5 mm. Two test objects, an overlay of microcalcifications on top of microbubbles and a mouse lung specimen, were used to perform the initial evaluation of the prototype system.

RESULTS

In addition to the conventional absorption contrast tomosynthesis imaging, x-ray dark field tomosynthesis imaging provided complementary image information for detailed structures in the two specimens. The contrast-to-noise ratio of the low-attenuating microbubbles was boosted from 5.9 in absorption tomosynthesis images to 21.0 in dark field tomosynthesis images.

CONCLUSION

A clinically compatible x-ray dark field breast tomosynthesis prototype system was developed. Based on the promising initial results using both phantom and biological specimen studies, this system will be used to evaluate the potential clinical utility of x-ray dark field tomosynthesis imaging.

CLINICAL RELEVANCE/APPLICATION

This is the very first report of a prototype x-ray dark field tomosynthesis system that will enable future clinical evaluation of the x-ray dark field breast tomosynthesis imaging method.

SSG14-08 A Novel Automatic Segmentation Algorithm for Tissue Classification of Dedicated Breast CT Images

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S405AB

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PURPOSE

To develop and validate a fully automatic classification algorithm to identify voxels containing skin, adipose, fibroglandular and vasculature in dedicated breast CT (BCT) images.

METHOD AND MATERIALS

The developed algorithm involves the following steps: i) an intensity and region-based segmentation method for skin detection; ii) a combination of unsupervised neural networks and energy minimizing splines for fibroglandular tissue segmentation and iii) an unsupervised data mining approach to classify the remaining tissue into fat and vasculature. To evaluate the accuracy of the algorithm, one slice each from five different patient BCT images were manually segmented under the supervision of an experienced breast radiologist and considered the gold standard. To evaluate the robustness of the algorithm to image noise, Gaussian, Poisson and speckle noise were separately added to another five patient BCT slices. Finally, to evaluate the classification of the vasculature, three different pre- and post-contrast injection patient BCT images were classified and compared. Dice Similarity Coefficients (DSCs) were calculated for all comparisons.

RESULTS

The DSCs between the manually and automatically segmented slices were (mean ± 1 std.dev): skin: 0.949 ± 0.005; fibroglandular: 0.955 ± 0.009; adipose: 0.986 ± 0.016; vasculature: 0.879 ± 0.052. The DSCs between the original segmentation result and the ones corrupted by noise were 0.887 ± 0.07 for Gaussian, 0.920 ± 0.06 for speckle and 0.912 ± 0.03 for Poisson noise. Finally, the vasculature DSCs for the three patient cases between the pre- and post-contrast injection images were 0.974, 0.952 and 0.891.

CONCLUSION

The algorithm results in accurate and robust breast tissue classification with no prior training and with the ability to detect blood vessels even in non-enhanced images. Potential applications include breast density quantification and tissue pattern characterization, both biomarkers of cancer development. Further possibilities include automatic identification of breast skin thickening, related to cancer development, and development of patient image-based phantoms which could be used for breast imaging research.

CLINICAL RELEVANCE/APPLICATION

Classification of breast CT images can provide quantitative assessments of breast tissue composition, density and distribution, all biomarkers of breast cancer development.

SSG14-09 Patient-Based 4D Digital Phantom for Dynamic Contrast-Enhanced Breast CT Imaging

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S405AB

Participants
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PURPOSE

To develop a realistic patient-based 4D digital breast phantom including time-varying contrast enhancement for dedicated breast CT perfusion imaging.

METHOD AND MATERIALS

A phantom was created by first segmenting a breast CT scan from a healthy patient into skin, fibroglandular tissue, adipose tissue and vasculature using an automated classification algorithm developed in our laboratory. A tumor model (a sphere with a radius of 10 voxels, equivalent to 2.6 mm) was inserted within the segmented fibroglandular tissue. Average values for blood volume and wash-in and wash-out rates were defined for each tissue type and for the tumor based on results from contrast enhanced dynamic breast MRI. Given these parameters, the proposed algorithm automatically calculates input functions for each tissue type, including the tumor. Then, blood flow (BF) and mean transit time (MTT) are computed for each voxel, taking into account the Hounsfield unit values from the original patient image. Finally, time attenuation curves are calculated for each voxel by convolving the inputs with an exponential function that depends on the BF and MTT values associated with that voxel.

RESULTS

The first 4D voxel phantom constructed in the present study has dimensions of 1008x1008x198x560 (x, y, z, t) with a sampling time of 1 s. Results show the expected enhancement of tissues according to the given input parameters. Moreover, the tumor presents a higher and much faster enhancement compared to the other healthy tissues, as expected. Additional phantoms from other patient cases can be generated at will.

CONCLUSION

The proposed digital phantom can model the behaviour of contrast in the breast during 4D breast CT image acquisition, displaying the different enhancement dynamics that may be found in a patient breast. These phantoms will be used to optimize the development of dynamic contrast enhanced dedicated breast CT imaging to obtain the highest possible image quality with the minimum possible dose. Future work includes the evaluation of the enhancement of different tumor types, 4D breast CT simulations and estimation of radiation dose.

CLINICAL RELEVANCE/APPLICATION

The proposed phantom can be used for optimizing 4D breast CT imaging, which has the potential to aid in the staging and characterization of breast tumors and in the monitoring of treatment.

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103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
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SSG15

Physics (CT: Image Quality)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S503AB

CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSG15-01 Efficient and Quantitative CT Protocol Optimization using Channelized Hoteling Observer

Tuesday, Nov. 28 10:30AM - 10:40AM Room: S503AB

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PURPOSE

To develop a framework and software tool for efficient optimization of CT protocols using a channelized Hotelling observer (CHO) and associated task-based image quality metrics.

METHOD AND MATERIALS

The lack of efficient tools for CT image quality assessment and protocol optimization has been one of the main reasons for a large variation of radiation dose among CT practices. In this work, we developed a quantitative framework for protocol optimization and a software tool to address this issue. A phantom containing 21 objects of various contrast levels and sizes was 3D-printed and inserted into anthropomorphic phantoms of 3 sizes to mimic different adult attenuation levels. The software tool consists of two major components: (1) automated CHO calculation and (2) protocol optimization. The first component performs automated CT image quality assessment after loading the phantom images, which includes calculation of contrast-dependent spatial resolution, 2D and 3D noise power spectrum, index of detectability (d'), and area under the ROC curve (AUC) for a low-contrast detection task. The AUC and d' were based on a previously validated CHO model, with Gabor channels optimized to improve the statistical performance. The second component of the software tool automates the process of protocol optimization by using a predefined target AUC value or an AUC value associated with a reference protocol. As an example, the tool was tested on a 128-slice scanner to determine the dose reduction potential of iterative reconstruction (IR) in a routine abdomen/pelvis protocol.

RESULTS

CHO can be efficiently calculated using the developed tools with the number of Gabor channels reduced to 12 and the required number of repeated scans reduced to 15-20 without sacrificing the CHO accuracy. In the example of protocol optimization for IR, when the predefined target AUC was 0.9, acceptable dose reduction was between 20% and 30%, depending on the phantom sizes.

CONCLUSION

The developed framework for protocol optimization and software tool allows for efficient and objective determination of task-based image quality, which can be used for quantitative protocol optimization in CT.

CLINICAL RELEVANCE/APPLICATION

CT protocols can be efficiently and objectively optimized using the proposed quantitative method based on model observers, which may lead to reduced dose variation across CT practice.

SSG15-02 Task-based Parameter Optimization for Low Signal Correction in Low-Dose CT

Tuesday, Nov. 28 10:40AM - 10:50AM Room: S503AB

Participants

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PURPOSE

Low signal correction (LSC) techniques applied to raw projection data in CT are an effective means to reduce noise streaks and noise amplitude in CT, enabling high quality CT images at reduced dose levels. Current empirical parameter selection in LSC requires many trial-and-error experiments, and often leads to variable performance for different imaging tasks. The purpose of this work is to present a task-based parameter optimization framework for LSC methods in low dose CT.

METHOD AND MATERIALS

Since LSC methods reduce noise in the raw data locally, noise and spatial resolution may not be uniform across the field of view (FOV). In the proposed framework, noise and spatial resolution were measured through repeated scans at a given dose level and incorporated into a mathematical observer model to calculate detectability. The detectability index was then used as figure of merit to optimize parameter selection for a given LSC method. Detectability maps obtained for a given LSC parameter space were incorporated into the following parameter selection criteria: a) maximize detectability for a given imaging task and given spatial location, b) maximize global detectability across imaging tasks for a given location, c) maximize detectability for a given imaging task across spatial locations, or d) maximize global detectability across imaging tasks and across locations.

RESULTS

Noise and spatial resolution properties were found to vary considerably across the FOV. Once these metrics were incorporated into the detectability index, the imaging performance for a given operating point in the parameter space was found to have a strong dependence on spatial location and imaging task. The proposed parameter selection criteria addressed the selection of the optimal filter parameters for LSC.

CONCLUSION

A task-based detectability framework was developed to optimize the selection of parameters for LSC. This framework is generalizable to any LSC methods that can be parameterized.

CLINICAL RELEVANCE/APPLICATION

LSC methods play an essential role in low dose CT technologies. An imaging task-based parameter selection framework can provide a means to achieve radiation dose reduction while to maintain diagnostic performance in low dose CT exams.

SSG15-03 CT Number Bias in Low Dose MDCT with Model Based Iterative Reconstruction (MBIR)

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S503AB

Participants
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PURPOSE

New technologies have been developed and deployed in the field to enable radiation dose reduction. Although clinical benefits seem to be apparent, the potential challenges associated with radiation dose reduction have not been fully investigated. In this work, systematic studies were performed to investigate the change of CT number bias from reference with the decrease of radiation exposure levels and to compare the potential difference between CT number bias in conventional FBP reconstruction and model based iterative reconstruction (MBIR).

METHOD AND MATERIALS

To extract CT number bias, multiple repeated scans were performed on a quality assurance phantom and a clinical MDCT system equipped with both FBP and MBIR reconstruction methods. The CT number of 7 inserts with different attenuation levels was measured from a combined set of 10 exposure levels and 3 tube potentials, with each parameter set repeated 50 times. These measurements were finally compared to a reference consisting of the average of an ensemble of 50 scans obtained at a reference dose level at each kV. CT number bias was defined as the difference between the ensemble average CT number measured at a given exposure level and the ensemble average CT number measured at a reference exposure level for a given kV.

RESULTS

There are three important findings from this work: (1) CT number bias increases with decreasing radiation dose levels for both FBP and MBIR; (2) For a given material insert, the CT number biases in FBP and MBIR are completely inverted, i.e., for FBP a positive bias was obtained as the exposure level decreased; in stark contrast, for MBIR the bias becomes negative at low exposure levels; (3) CT number bias was found to be proportional to its own CT number level for both FBP and MBIR.

CONCLUSION

CT number bias increases with radiation dose reduction in both FBP and MBIR and a peculiar CT number bias inversion with respect to FBP, was experimentally observed for MBIR as exposure level was reduced.

CLINICAL RELEVANCE/APPLICATION

The discovery of increased CT number bias in low dose CT sets a new lower bound for radiation dose reduction to maintain diagnostic accuracy in low dose CT clinical exams.

SSG15-04 CT Iterative Reconstruction Kernels: Noise Characteristics and Their Differences

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S503AB

Participants
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Victor Weir, PHD, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To better understand noise characterization of computed tomography (CT) images reconstructed with iterative reconstruction kernels and demonstrate their differences.

METHOD AND MATERIALS

Unsubtracted and subtracted noise power spectra (NPS) and modulation transfer function (MTF) were measured using CT images acquired from a routine water phantom on Siemens Definition Edge, Force, and GE Revolution, respectively. Series of cutting-edge iterative reconstructions in Sinogram Affirmed Iterative Reconstruction (SAFIRE I31f-I70f), Advanced Modeled Iterative Reconstruction (ADMIRE I31f-I70f, and Br20s-Br70s in dual-source), and Advanced Statistical Iterative Reconstruction-V (ASIR-V Bone, Lung, Detail, Standard) were evaluated and compared at different strength settings (1-5 for Siemens, 20-100 for GE).

RESULTS

Each NPS demonstrates the expected shape of traditional back-projection filters. The peak frequency gradually shifts to lower frequency with the increased strength, corresponding to stronger smoothing effect. Low-frequency structured noise is observed in unsubtracted NPS for all kernels and is successfully removed in subtracted NPS. With the increases in filter sharpness, the NPS shifts to higher frequencies, preserving higher-frequency noise. The series of I kernels in SAFIRE and ADMIRE demonstrate comparable NPS. However, the Br kernels in ADMIRE dual-source shows differences from I kernels. There are notable differences in the NPS between manufacturers. Comparing the NPS of ADMIRE and ASIR-V shows that the GE kernels generally exhibit a larger decrease in peak noise resolution due to increasing kernel strength and a generally wider NPS profile than comparable Siemens kernels. Over-enhancing is observed in all sharp kernels.

CONCLUSION

Analysis of NPS helps characterize image noise associated with various reconstruction kernels and identify their differences to help in their clinical application. A comparison between manufacturers potentially helps standardize protocols across different CT scanners.

CLINICAL RELEVANCE/APPLICATION

Understanding how reconstruction kernels affect noise pattern allows tailoring protocols to task-specific clinical applications.

SSG15-05 Contrast Dose Reduction in Coronary CT Angiography on 16cm Wide-Detector CT with Reduced Injection Time

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S503AB

Participants
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PURPOSE

To investigate the effect of contrast agent injection time on coronary artery image quality in coronary CT angiography (CCTA) with wide-detector CT.

METHOD AND MATERIALS

A total of 40 patients underwent CCTA on a 16cm wide-detector Revolution CT with 100kVp tube voltage and automatic tube current modulation for noise index of 21HU. The contrast agent iopamidol (370mg/ml) was used at a dose rate of 25mgI/kg/s. The patients were divided into two groups based on the injection time: Group A (n=20 with standard 12s injection time) and Group B (n=20,8s) The CT value and standard deviation in the lumen of the ascending aorta,right coronary artery,left anterior descending branch,proximal lumen of LCX and adjacent tissue were measured to calculate the contrast-to-noise ratio (CNR) and signal-to-noise ratio (SNR) for arteries. Two imaging radiologists with cardiovascular diagnosis experience over 8 years assessed image quality independently for subjective score using a 5-point scoring system (5: best,1: worst,>= 3: diagnosable). Measurements between the two groups were compared using T test or rank sum test.

RESULTS

There was no significant difference in age,heart rate and body mass index between the two groups (P>0.05); The CT number,SNR,CNR,effective dose and subjective score of the two groups were statistically the same (p>0.05). There was a significant difference in contrast dose between group A (54.7±8.3ml) and group B (37.9±6.5ml) (P<0.05),a reduction of about 30%.

CONCLUSION

Reduction of contrast injection time from the conventional 12s to 8s in CCTA with 16cm wide-detector CT effectively reduces contrast dose by 30% while maintaining image quality.

CLINICAL RELEVANCE/APPLICATION

Faster scan time enables the shortening of contrast injection time to save contrast dose by 30% while maintaining image quality in CCTA with 16cm wide-detector.

SSG15-06 Framework for Objective Clinical Image Quality Assessment in Thorax CT: A 3D Model Observer in Combination with A 3D Printed Lung Phantom Containing Nodules

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S503AB

Participants
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PURPOSE

To apply a 3D model observer to analyze the detectability of lung nodules in a 3D printed lung phantom in CT images acquired at different dose levels.

METHOD AND MATERIALS

A model of the distribution of the lung vessels, based on published morphometry based human data, was generated using an in-house algorithm developed in MATLAB. The simulated lung vessels had diameters between 8.5 and 0.2mm. The model was printed in a ProJet HD 3000 3D printer using Visijet EX200 as material. A PMMA thorax shaped holder (20x30x3cm3) was created to contain the lung insert. Twenty cork spheres (6mm diameter) were placed at different positions as nodules surrogates. The phantom was scanned with a thorax protocol (Toshiba Aquilion Genesis, 120kV, collimation=0.5x80mm, pitch=0.637, RFOV=400mm, AIDR3D, FC18 kernel, 0.5mm slice thickness and interval, 250-30-5-3mAs)). Twenty acquisitions were performed for each dose level, 10 with lesions and 10 without. Volumes of interest (16x16x8.5mm3), centered on the nodule locations, were selected. Volumes were also cropped in equivalent anatomical positions in the nodule-free images. For the highest dose, ROIs were taken on the bigger vessels and also in the central slice of the nodules to estimate their attenuation. A 3D channelized Hotelling model observer (CHO) , with 20 Gabor channels was used to analyze the samples with and without lesions for each dose level. Half of the images were used for training and half for testing for each condition. Test-statistics were calculated over the distributions of the model observer outcomes and a detectability index was calculated for each dose level.

RESULTS

The phantom vessels had a mean pixel value of (118±5HU) and the nodules (-815±20HU). The detectability of the lesions increased with increasing mAs value, for the 3D model observer. The d' values, from highest to lowest dose level (CTDIvol=10.9-2.6-0.4-0.2mGy) were (13.8±1.1, 11.2±0.8, 8.3±0.6, 7.5±0.5).

CONCLUSION

A 3D model observer was applied to analyze the detectability of nodules in CT images of a 3D printed lung phantom mimicking the human vessel distribution. The detectability of the lesions increased with dose. These results represent a step towards measurement of clinical image quality with 3D model observers in CT.

CLINICAL RELEVANCE/APPLICATION

A 3D model observer can be a useful tool towards measuring clinical image quality in CT, in particular, for lung nodule detection tasks in a 3D printed lung phantom.

SSG15-07 Noise Suppression Dependency on Patient Size and Lesion Size with Adaptive Statistical Iterative Reconstruction in Adult Abdomen CT

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S503AB

Participants
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PURPOSE

To demonstrate the noise suppression dependency on patient size, lesion size and dose with adaptive statistical iterative reconstruction (ASIR) in adult abdomen CT.

METHOD AND MATERIALS

Three adult abdomen phantoms simulating the small, medium and large patient were scanned using a GE VCT 64-slice scanner.

Different dose levels were applied (CTDI_vol 2 mGy to 40 mGy). The images were reconstructed with variable ASIR fractions (0 - 100%). The noise images were obtained using subtraction between eight nearest neighbor slices. They were partitioned into matrices of square elements scaled 1.8 mm - 10 mm to match the lesion sizes of interest, and the statistically defined minimum detectable contrast (MDC) were computed to represent the noise suppression. To describe the relative noise suppression over FBP images, the normalized MDC (N_MDC) was defined as the ratio of the MDC with ASIR to the MDC with FBP. N_MDC was obtained at each element size from different ASIR blending fractions at variable dose levels.

RESULTS

N_MDC was found to decrease linearly as the ASIR blending fraction increases. The slope of the N_MDC, however, depends on the lesion size, patient size and dose. The slope was fitted against the lesion size by a power law with more contrast enhancement at smaller lesion size ($R^2 > 0.935$ among all cases). The contrast enhancement or noise suppression was found to be more pronounced as the phantom size increases or as the dose decreases. The difference on noise suppression due to different doses was also observed smaller for the smaller lesion sizes.

CONCLUSION

The suppression using ASIR in adult abdomen CT not only depends on the ASIR blending fraction, but also depends on the lesion size, patient size and dose.

CLINICAL RELEVANCE/APPLICATION

Adult abdomen CT dose optimization

SSG15-08 Impact of Iterative Reconstructions on Image Quality in Clinical CT Images Demonstrated by a Novel Noise Power Spectrum Measurement Tool

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S503AB

Participants
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PURPOSE

To quantify noise texture and magnitude characteristics of clinical Computed Tomography (CT) images obtained with Iterative Reconstructions (IR) techniques.

METHOD AND MATERIALS

An algorithm was developed to extract noise texture and magnitude metrics from 10 chest and abdomen clinical CT-scans (Discovery CT750 HD; GE Healthcare, Wisconsin) performed for oncology follow-up by measuring a global Noise Power Spectrum (NPS). After subtraction of adjacent slices, a segmentation algorithm was applied to exclude remaining anatomical structures. Noise magnitude (i.e. area under the 1D-NPS curve) and peak frequency (fpeak) were measured, within all the available regions of interest that did not contain edge pixels, and compared for chest and abdomen on image subsets of all CT scans reconstructed using Filtered Back Projection (FBP), Adaptive Statistical Iterative Reconstruction 30 % (ASIR30), 50 % (ASIR50) and Model-Based Iterative Reconstruction (MBIR).

RESULTS

Compared to FBP, ASIR30 and ASIR50, MBIR reduced noise magnitude by 31 %, 17 % and 13 % in chest and by 47 %, 34 % and 29 % in abdomen respectively ($p < 0.01$ each). These noise magnitude reductions were also associated to changes in noise texture: for chest and abdomen, fpeak were significantly lower for MBIR (0.08 and 0.09 mm^{-1} respectively), ASIR50 (0.13 and 0.14 mm^{-1} respectively) and ASIR30 (0,16 and 0.18 mm^{-1} respectively) compared to FBP (0.23 and 0.27 mm^{-1} respectively; $p < 0.01$ each).

CONCLUSION

Assessing NPS of clinical CT examinations can demonstrate the reduction of noise magnitude and the changes of noise texture associated to IR. This method could be used to tailor CT protocols according to radiologists' preferences regarding noise texture and magnitude.

CLINICAL RELEVANCE/APPLICATION

The proposed technique enables automatic quality control monitoring of image noise characteristics in clinical practice.

SSG15-09 Objective Quantification of the Impact of Image Artifacts on Lesion Detectability Using a Channelized Hotelling Model Observer

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S503AB

Participants
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PURPOSE

Objective assessment of the impact of image artifacts on the diagnostic quality of a cone-beam CT (CBCT) images is difficult, as conventional image quality metrics are not adequate to assess the influence of non-uniform artifacts. In this work, we investigated the use of a channelized Hotelling observer (CHO) to quantify the impact of artifacts arising from both the test object and external sources on lesion detection in CBCT data.

METHOD AND MATERIALS

A custom phantom insert containing vessels of diameter 2, 4 and 8 mm was filled with diluted iodine contrast medium to produce different image contrast levels (range 0-300 HU) and placed inside an anthropomorphic thoracic phantom. Projection images were acquired at 1.5º/frame over a 200º range using a C-arm. Severe external image artifacts were introduced by placing two metal pins adjacent to the posterior surface of the phantom. Detectability index (d') of a CHO was estimated using 150 background only images and 150 images of the iodine vessels with and without external artifacts. Using a standard CHO implementation, the total contribution of the vessels and artifacts to d' was estimated. The contribution of the artifacts was determined by masking the image area of the iodine vessels prior to channelization. d' of the artifacts was then subtracted from the total d's to estimate d' of the iodine vessels only.

RESULTS

Per expectation, the contribution to d' of artifacts originating from the iodine vessels was proportional to the HU contrast of the iodine vessels whereas that of the external artifacts was independent of iodine concentration. As the severity of the externally produced artifacts was variable across the 2D images, their estimated contribution to d' was also variable with location in the image. After correcting for external artifacts, d' of the iodine vessels with external artifacts present was 4-67% lower than that without external artifacts.

CONCLUSION

This work proposes masking of the test object to directly estimate CHO d' of CBCT image artifacts arising both from the test object and external sources. This method may be used to directly estimate the magnitude of image artifacts and to remove their influence on d' estimates.

CLINICAL RELEVANCE/APPLICATION

Artifacts present in CBCT images can confound CHO performance. A correction method is proposed to eliminate their effect and provide valuable information on their influence on lesion detection in CBCT.

SSG16

Science Session with Keynote: Radiation Oncology (Genitourinary)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: S104A

GU RO OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Martin Colman, MD, Houston, TX (*Moderator*) Nothing to Disclose
Abhishek A. Solanki, MD, Maywood, IL (*Moderator*) Consultant, Blue Earth Diagnostics Ltd; Advisory Board, Blue Earth Diagnostics Ltd

Sub-Events

SSG16-01 Radiation Oncology Keynote Speaker:

Tuesday, Nov. 28 10:30AM - 10:50AM Room: S104A

Participants
Abhishek A. Solanki, MD, Maywood, IL (*Presenter*) Consultant, Blue Earth Diagnostics Ltd; Advisory Board, Blue Earth Diagnostics Ltd

SSG16-03 Patients Treated with Volumetric Modulated Arc Therapy for Prostate Cancer Return to Baseline Urinary Function Following Treatment to 81 Gy

Tuesday, Nov. 28 10:50AM - 11:00AM Room: S104A

Participants
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Mitchell D. Terk, MD, Jacksonville, FL (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The purpose of the abstract was to determine both the acute and long terms consequences of VMAT to 81Gy for prostate cancer in a cohort of 501 men treated between 8/2010 and 12/2015 using a validated measure of urinary function.

METHOD AND MATERIALS

Five hundred and one men were treated with VMAT to 81 Gy from 8/2010 to 12/2015 for low (27.5%), intermediate (47.7% and high risk (24.8%) prostate cancer. In addition to the use of VMAT, patients were treated using gold fiducial markers, a rectal stabilization device and MRI treatment planning. All men were given the International Prostate Symptom Score sheet prior to treatment, at one month following treatment and at one year. IPSS scores were prospectively collected and comparisons of means were made by T-test. The incidence of elevations in IPSS which have been previously described to be bothersome to men and require either medical or surgical intervention are also reported.

RESULTS

The baseline IPSS score prior to therapy was 9.57 for the entire cohort, at one month following completion of radiation the average score was 10.51 ($p=0.003$) and at one year 9.23 ($p=0.17$). 119/501 (23.8%) of patients began treatment with an IPSS score great than or equal to 15 with an average score of 19.65. At one month following treatment the IPSS score was 15.34 ($p<0.01$) and at a year 13.9 ($p<0.01$). For patients with baseline IPSS less than 15, the average score prior to therapy was 6.49, and at one month and one year 9.01 and 7.66 respectively ($p<0.01$). For 171 (34.1%) patients who were initially asymptomatic, IPSS less than or equal to 5, the average IPSS prior to treatment was 2.81, and at one month and one year 7.08 and 6.29 ($p<0.01$). When evaluated individually, 111/501 (22.2%) patients experienced a rise in IPSS of at least 5, 46/501 (9.1%) of 10, 15/501 (3.0%) of 15 and 6/501 (1.2%) of 20 points. No patient required catheterization at any point or use of pads.

CONCLUSION

Patients who were highly symptomatic prior to VMAT therapy experienced improved urinary function prior to baseline measurements at one month following treatment and continued improvement on to one year of treatment. Very few patients experienced a clinically signficant rise in IPSS of greater than 15 and 20 from their pretreatment baseline measurements. No patient experienced catheterization or incontinence.

CLINICAL RELEVANCE/APPLICATION

Prostate cancer treatment to very high doses is associated with minimal urinary toxicity.

SSG16-04 Differences in Prostate Gland Geometry and Dosimetry After Pre-operative and Intra-operative Ultrasound Planning in Patients Undergoing Prostate Seed Brachytherapy: Implications for Current Practice

Tuesday, Nov. 28 11:00AM - 11:10AM Room: S104A

Participants
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PURPOSE

Currently prostate brachytherapy (PB) plans are generated using either pre-operative (POP) (done 2-3 wks before PB) or intra-operative (OR) ultrasound volume studies. This report compared: A) Prostate geometry between POP and OR volume studies; B) Prostate I-125 seed distribution between POP and OR plans; C) Prostate dosimetry after OR planning and POP planning.

METHOD AND MATERIALS

The POP and OR ultrasound volume studies and PB plans of 30 patients were analyzed and compared. PB dose was 144Gy with I-125 seeds. Different prostate gland volumes (cc) receiving a %dose (V100% and V150%) and dose to % prostate volumes (D90%) were estimated and compared using Wilcoxon rank sum test.

RESULTS

A) Mean prostate volume (cc) after POP vs. OR scans respectively and P values (P) was: prostate base 23.4 $\pm$ 3.2 vs. 22.8$\pm$ 3.0 (P 0.35); prostate mid gland 24.0$\pm$ 3.6 vs. 22.6$\pm$ 2.8 (P 0.003); prostate apex 11.4$\pm$3.1 vs. 10.3 $\pm$ 2.5 (P 0.07). B) Median difference in number of I-125 seeds between POP and OR plans were: Base 2.0 $\pm$ 4 (P 0.03); Mid gland 2.0 $\pm$ 9.6 (P 0.4); Apex 2.0 $\pm$ 6.4 (P 0.02). Median number of seeds added or removed for the 2 plans were: +4 and -2 for Base; +4 and -3.5 for Mid gland and +7.5 and -6.5 for Apex. These changes in number of seeds in the apex and base indicates significant difference in prostate geometry between these scans. C) Mean prostate PTV (cc) (V100% dose) between OR vs. POP plans was: Base 22.0$\pm$4 vs. 21.7$\pm$2.9 (P 0.004); Mid gland 23$\pm$4.3 vs. 22.7$\pm$3.2 (P 0.03) and Apex 10.8$\pm$3.3 vs. 10.2$\pm$3.3 (P 0.03). Mean prostate PTV (cc) (V150% dose) between OR vs. POP plans was: Base 10.8$\pm$4.0 vs.10.4$\pm$2.6 (P 0.049); Mid gland 12.2$\pm$4.2 vs.12.0$\pm$2.6 (P 0.3) and Apex 4.9$\pm$1.9 vs. 4.3$\pm$1.8 (P 0.02). Dose to 90% prostate PTV (D90) for OR vs. POP plans was 119$\pm$16% vs. 113$\pm$20% (P 0.04).

CONCLUSION

There were significant differences in prostate geometry and dosimetry between OR and POP scans. Differences in patient positioning (hip flexion) and use of general anesthesia for OR plans were responsible for these observations. The use of POP scans for PB may result in higher relapse rates due to underdosage of at-risk regions in the prostate. Intra-operative ultrasound volume study-based PB treatment planning provides superior prostate dosimetry compared to preoperative planning.

CLINICAL RELEVANCE/APPLICATION

Intra-operative volume study-based PB planning delivers a higher target dose to the prostate gland compared to pre-operative planning.

SSG16-05 Multiparametric MRI for Renal Cell Carcinoma: Assessment of Tumor Response after Stereotactic Ablative Body Radiotherapy

Tuesday, Nov. 28 11:10AM - 11:20AM Room: S104A

Participants
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PURPOSE

Response assessment of renal cell carcinoma (RCC) after stereotactic ablative body radiotherapy (SABR) using size criteria from CT is challenging, as changes may evolve over months and even years post-therapy. The purpose of this study was to analyze early diffusion and perfusion changes in RCC tumors shown by multiparametric MRI after SABR, and to assess whether any changes are associated with overall treatment response.

METHOD AND MATERIALS

Twelve patients in a prospective Phase Ib clinical trial were analyzed, where patients with RCC tumour size <5cm diameter received a single fraction of 26 Gy and larger lesions received three fractions of 14 Gy. Multiparametric MRI including diffusion weighted (DWI) and dynamic contrast-enhanced (DCE) imaging was acquired at baseline and approximately three weeks and three months after SABR. Apparent diffusion coefficient (ADC) maps were computed from DWI data, heuristic parametric and pharmacokinetic maps using the extended Tofts model were fitted to the DCE data. Tumour volumes were contoured and statistics including histogram metrics extracted. Changes in DWI and DCE MRI characteristics were correlated with change in tumour volume shown by late follow-up CT (average 28 months after baseline CT, range 17-40 months) and with the Response Evaluation Criteria in Solid Tumors (RECIST) criteria.

RESULTS

The ADC mean, median and kurtosis measures increased in most patients at the third MRI scan indicating increased diffusion after

SABR, however there was no clear correlation with the change in tumour volume. DCE analysis showed strong correlations between the change in enhancement curve type and the change in tumor volume. Pharmacokinetic maps showed a positive correlation between tumour volume change and the difference in Ktrans, and a negative correlation with the change in Ve, at the third MRI scan.

CONCLUSION

Voxel-based analysis of tumors using DCE MRI shows promise for early prediction of overall tumour response, and may provide a useful biomarker for guiding patient management which is more reliable than RECIST criteria. DWI analysis did not provide a strong early indicator of treatment response.

CLINICAL RELEVANCE/APPLICATION

DCE MRI after SABR treatment for RCC may provide novel early response biomarkers which are more reliable than conventional CT based geometric RECIST response criteria.

SSG16-06 High Quality Volumetric CT Reduces PTV Margin for Radiotherapy of Prostate Cancer

Tuesday, Nov. 28 11:20AM - 11:30AM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): To determine whether superior soft tissue contrast provided by high-dose-high-quality volumetric CT (HDVCT) scans can reduce inter-observer variability in prostate gland segmentation which may results in the reduction of PTV margin.Materials/Methods: Ten prostate patients receiving radiotherapy were imaged with conventional CT (CCT, 120kV, 300mAs), HDVCT (120kV, 2300mAs, 80 slices of volumetric scan) and 3T MRI (T2W) all with 2mm thickness. Five radiation oncologists delineated prostate gland on all three image sets, totaling 150 contoured target volumes. Inter-observer variability was measured along base/middle/apex, posterior/anterior, and left/right directions. Degree of target confidence was measured in terms of membership by counting the number of times that each image voxel (0.2mmx0.2mmx2.0mm) were enclosed by contours delineated by five observers. A modal target volume was defined by the voxels with the membership of 50% or more in each imaging modality used. PTV margin was calculated by expanding every 150 contours with a step size of 0.5mm to 10mm that guarantees 95% of the prescription dose to the modal target volume to more than 90% of patient population. When contours to be expanded and the modal target volume to be covered are from the same image modality, the PTV is called intra modal PTV margin, and with different imaging modality, it is called inter modal PTV margin. Intra and inter modal PTV were compared for each image modality. Results: Inter-observer variability was 2.0mm, 2.0mm, and 1.7mm on average and 2.5mm, 2.1mm and 2.0mm with the maximum in apex region for CCT, HDVCT, and MRI, respectively (pConclusion: Inter-observer variability in target delineation is a source of systematic uncertainty. HDVCT CT and MRI imaging demonstrated significant reduction in inter-observer variability and intra PTV margin compared to CCT. Inter modal PTV margin appears minimal with HDVCT (5mm) than CCT or MRI (6mm) although the average volume of HDVCT is smaller than that of CCT. Smaller target volume together with smaller inter/intra PTV margin for HDVCT is promising for radiotherapy planning of prostate cancer.

SSG16-07 Early Urinary and Sexual Toxicity Outcomes for Patients Receiving Proton Radiation for Prostate Cancer

Tuesday, Nov. 28 11:30AM - 11:40AM Room: S104A

Awards
Student Travel Stipend Award

Participants
Meghan W. Macomber, MD, Seattle, WA (*Presenter*) Nothing to Disclose
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PURPOSE

While proton therapy becomes increasingly available to patients with prostate cancer, only a few centers have published their clinical results to date. We present our 2-year results using proton beam therapy (PBT) to treat patients with prostate cancer.

METHOD AND MATERIALS

82 patients on an IRB approved institutional registry were treated with PBT from 2013-2015. CTCAE v4.0 was used to score toxicity. Univariate and multivariate Cox regression were performed to identify clinical and dosimetric predictors of toxicity.

RESULTS

For the 82 patients treated, 23 had low risk prostate cancer, 42 intermediate risk, and 17 high risk. 95% of patients received >=78 CGE. 25 patients received androgen deprivation therapy (ADT). Median follow up was 2 years. Time to PSA nadir was 1 year, with an average nadir of 0.5 ng/mL for patients treated with radiation alone without androgen deprivation. Two-year grade 2 and 3 GU toxicity were 22.0% and 1.2% respectively. Median time-to-event for G2+ urinary toxicty was 8 months. Univariate analysis showed a significant correlation between grade 2+ urinary toxicity and pretreatment prostate reductive procedures such as TURP

(p=0.009), ADT use (p=0.006), baseline IPSS score (p=0.02) and baseline IPSS bother score (p=0.01). Relative volume of bladder receiving 81 Gy was also significantaly related to G2+ urinary toxicity (p=0.04). On multivariate analysis, ADT use and baseline IPSS bother score correlated significantaly with grade 2+ toxicity (p=0.006 and p=0.01).Two year rates of grade 2 and 3 decline in erectile function were 19.5% and 1.2%, respectively. On univariate analysis, only age was significant for grade 2+ sexual toxicity (p=0.001). There were only two events of grade 2 hip pain.

CONCLUSION

Rates of grade 2+ urinary, sexual, and hip toxicities were acceptable after proton therapy for prostate cancer. The highest risk subgroup for developing urinary toxicity was men on ADT with high baseline IPSS bother scores. Future analysis will include larger patient numbers and longer follow up to better assess late treatment toxicities and PSA trends.

CLINICAL RELEVANCE/APPLICATION

Our preliminary results show acceptable rates of urinary, sexual, and hip toxicity in patients with prostate cancer treated with proton therapy, with adequate PSA response.

SSG16-08 Analysis of 2-Year Gastrointestinal Toxicity in Patients Receiving Proton Radiation Therapy for Prostate Cancer

Tuesday, Nov. 28 11:40AM - 11:50AM Room: S104A

Awards
Student Travel Stipend Award

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PURPOSE

Increasing numbers of patients with prostate cancer are being treated with proton therapy. Theoretically, proton beam therapy (PBT) may have dosimetric advantages over photon radiation in treating a smaller region of the rectum. An ongoing randomized trial of proton versus photon therapy for prostate cancer has bowel toxicity as the primary endpoint (PARTIQoL). We present the 2-year bowel toxicity data for patients treated for prostate cancer at our proton center.

METHOD AND MATERIALS

82 patients on an IRB approved registry were treated with PBT from 2013-2015. CTCAE v4.0 was used to score bowel toxicity. Univariate Cox regression was performed to test correlations of baseline patient and dosimetric features with grade 2 or higher bowel toxicity.

RESULTS

For the 82 patients treated, 23 had low risk prostate cancer, 42 intermediate risk, and 17 high risk. Ninety-five percent of patients received >=78 CGE, and 4 patients received pelvic node radiation. 25 patients received androgen deprivation therapy. 33 patients were treated with uniform scanning, and 49 patients were treated with pencil beam scanning. Median follow-up was 2 years. Radiation proctitis with transient rectal bleeding was the predominant bowel toxicity after PT, accounting for 95% of events. Grade 1 toxicity occurred in 15 patients (18%), grade 2 in 20 patients (24%), and grade 3 in 1 patient (1.2%). There were no grade 4 or 5 events. Median time to developing rectal bleeding was 14 months (range 5-33). Univariate analyses showed borderline correlation between grade 2+ toxicity and hyperlipidemia (p=0.05). No other associations to clinical variables, including use of anticoagulation, were observed. Dose-volume histogram parameters did not show a statistically significant correlation with grade 2+ toxicity, but the best correlation was with rectal V70 (p=0.11). No difference in toxicity risk was found between uniform scanning versus pencil beam scanning techniques.

CONCLUSION

We report 2-year bowel toxicity results from our proton center experience treating prostate cancer. A larger patient series with longer follow up is underway to better delineate the risk factors for development of bowel toxicity with proton radiation.

CLINICAL RELEVANCE/APPLICATION

Our preliminary results show acceptable rates of bowel toxicity in patients with prostate cancer treated with proton therapy, our studies are ongoing with larger patient numbers and longer follow up.

SSG16-09 The Impact of Magnetic Resonance Imaging on Clinical Decision-Making in Patients Undergoing Prostate Brachytherapy

Tuesday, Nov. 28 11:50AM - 12:00PM Room: S104A

Participants
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Courtney Hentz, Maywood, IL (*Abstract Co-Author*) Nothing to Disclose
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ABSTRACT

Purpose/Objective(s): Multiparametric magnetic resonance imaging (MRI) is increasingly being used to manage patients with prostate cancer. For brachytherapy (BT) patients, it can identify frank radiographic extracapsular extension (ECE) or seminal vesicle invasion (SVI) that may not be adequately covered by BT monotherapy. The objectives of our study were to identify predictors of ECE and SVI on MRI and determine how often MRI findings alter management in patients electing BT.Materials/Methods: We performed a retrospective cohort study of prostate cancer patients at our institution electing low dose rate (LDR) or high dose rate (HDR) BT and who underwent MRI prior to treatment. Patients with frank ECE or SVI on MRI were not recommended to undergo BT monotherapy and were offered either combined external beam radiotherapy + BT boost (CMT) or another approach. Clinical records were used to determine changes in physician recommendations due to MRI findings. Chi-Square tests were performed for univariate analysis (UVA) to determine covariates associated with ECE or SVI, including risk group, T-stage, Gleason score and group, prostate-specific antigen (PSA), percent positive cores (ppc; =50% vs. Results: The study cohort included 54 patients evaluated from August 2013 to January 2017 who elected BT (8 low risk, 40 intermediate risk and 6 high risk). 40 patients had cT1c disease, and 14 patients had cT2 disease. Median PSA was 6.51. 12 (22%), 30 (55%), 11 (20%), and 2 (4%) had Gleason group 1, 2, 3, and 5, respectively. 19 patients (35%) had =50% ppc. 13 patients had radiographic ECE (24%) and 2 (4%) had SVI. Only ppc =50% was associated with ECE (p=0.02); 15% of patients with ppc On MVA, ppc =50% continued to be associated with ECE (Odds Ratio 4.36, 95% Confidence Interval 1.17-16.3; p=0.29), but Gleason group did not (p=0.99). No variables predicted for SVI on UVA or MVA.No low risk or high risk patients had a change in recommendation due to MRI findings, but 20% (n=8) of the intermediate risk patients had a change in recommendation. 6 of these patients were switched from monotherapy to CMT due to ECE (and also SVI in 1 patient). One patient had hormonal therapy added to planned CMT. One patient had HDR recommended instead of LDR due to large gland size.Conclusion: MRI should be considered to help determine candidacy for BT monotherapy in intermediate risk prostate cancer patients and those with =50% ppc due to a higher risk of radiographic ECE that may not be adequately covered with monotherapy. Longer follow-up is needed to determine the impact on disease control.

SSG17

Vascular Interventional (Portal Hypertension/Transplant)

Tuesday, Nov. 28 10:30AM - 12:00PM Room: E351

GI IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

Nael E. Saad, MBBCh, Saint Louis, MO (*Moderator*) Research Consultant, Veran Medical Technologies, Inc; Proctor, Sirtex Medical Ltd
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Sub-Events

SSG17-01 Systematic Screening and Treatment Policy of Arterial Complications after Orthotopic Liver Transplantation: Long-Term Follow-Up

Tuesday, Nov. 28 10:30AM - 10:40AM Room: E351

Participants
Romain Breguet, MD, Geneva, Switzerland (*Presenter*) Nothing to Disclose
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PURPOSE

Vascular arterial complications after orthotopic liver transplantation (OLT) are actively searched for and treated to prevent the development of ischemic cholangiopathy (IC). To date, very few studies have analyzed the long-term outcome of this policy. Therefore the aim of this study was to evaluate the long-term results of a systematic screening and treatment policy of impaired hepatic artery after OLT.

METHOD AND MATERIALS

Between 2003 and 2013, over 1048 liver transplantations, a total of 53 patients (42 men, age 19-69) were diagnosed and treated by endovascular techniques for early or late arterial complications such as stenosis, thrombosis, dissection or kinking of the hepatic artery. Radiological and surgical data were retrospectively analyzed and survivors were recalled to undergo follow-up Magnetic Resonance Cholangiopancreatography (MRCP) and duplex ultrasound (DUS) of the liver to identify vascular anomalies and ischemic cholangiopathy. Factors associated with IC were identified.

RESULTS

Technical success was 94%, and 6 patients experienced serious adverse event. After a median follow-up of 56.7 months (range 15.6-123.6) DUS of the hepatic artery showed normal values (resistive index, time to peak and maximum velocity) in 72% of the patients. Over the same period, 17 patients (32%) developed radiological features of IC with a mortality rate of 13% compare to 10% in patients without IC (p=0.0163). Patients with arterial complication appearing before 3 months have significantly more IC when compared to others (p=0.028). No other factor was associated with the occurrence of IC. Patients with IC had a significantly lower survival (median 77 months (95% IC 53 - 101) vs. not reached in patients without IC, p = 0.0163).

CONCLUSION

Systematic screening and endovascular treatment of arterial complication after OLT appears safe, efficient and is associated with good long-term outcome. Nevertheless, one third of the patients eventually develop IC, especially if arterial complications appear early after OLT.

CLINICAL RELEVANCE/APPLICATION

Systematic screening and endovascular treatment of arterial complication after OLT appears safe, efficient and is associated with good long-term outcome, event though one third of the patients eventually develop IC.

SSG17-02 Volumetric Phase Contrast MR Imaging (4D Flow) of Transjugular Intrahepatic Portosystemic Shunts

Tuesday, Nov. 28 10:40AM - 10:50AM Room: E351

Participants

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PURPOSE

To demonstrate feasibility of interrogating transjugular intrahepatic portosystemic shunts (TIPS) with 4D Flow MR in patients with suspected TIPS dysfunction.

METHOD AND MATERIALS

Adult patients with suspected TIPS dysfunction were eligible for enrollment. A volumetric phase contrast sequence, with VENC 75-225 cm/sec, was used to image TIPS stents. Particle tracing CINE images were used for qualitative assessment of stenosis and stents were segmented to generate quantitative data sets of peak velocity. MR parameters were modified to improve image quality and post processing. Segmentation and quantitative measurement of flow throughout an entire TIPS stent defined technical success. Comparison was made to Doppler US and venogram (reference standards).

RESULTS

4D Flow MRA was performed in 23 encounters, was technically successful in 16/23 encounters, and failed in 7/23 encounters. The 3 cases which demonstrated both focal aliasing and abnormal velocities (>190cm/s or <90cm/s) on 4D Flow had venogram confirmed stenosis. The 4 cases which demonstrated elevated in-stent velocities >190 cm/s without focal aliasing, and the 2 cases with aliasing but normal velocities, did not have stenosis. Suboptimal imaging was due to low signal-to-noise related to FOV (3/5), ascites (1/5), or incorrect VENC selection (1/5). Failure of imaging occurred due to presence of stainless steel stent (2/7), improper FOV (3/7), incorrect VENC (1/7), and data corruption (1/7).

CONCLUSION

4D Flow MRA may be a feasible modality for the evaluation of TIPS stent dysfunction after protocol optimization and with careful patient selection to increase technical success

CLINICAL RELEVANCE/APPLICATION

4D Flow MRA is a promising modality for the evaluation of transjugular intrahepatic portosystemic shunt (TIPS) dysfunction, and could be incorporated into routine Liver MR protocols for improved surveillence of TIPS stents.

SSG17-03 Transhepatic Portomesenteric Stenting Improves Outcomes in Cancer Patients with Extrahepatic Portomesenteric Venous Stenosis/Occlusion

Tuesday, Nov. 28 10:50AM - 11:00AM Room: E351

Participants
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PURPOSE

To compare serologic and clinical outcomes between conservative management versus stenting in cancer patients with extrahepatic portomesenteric venous stenosis or occlusion.

METHOD AND MATERIALS

A single institution, IRB-approved retrospective review of all patients with extrahepatic portomesenteric venous occlusion or stenosis (PVO) from 2007-2015 was performed. A total of 347 patients were identified, of whom 38 underwent portomesenteric venous stenting (PVS). To reduce selection bias, a propensity score matching algorithm was used in a 2:1 ratio to create a subset of non-stent patients from the remainder of the 309 patients that were matched with the PVS cohort in age, underling malignancy, and extent of PVO. These matched 76 patients comprised the non-stent comparison cohort. Univariate and multivariate analyses of serologic and clinical parameters was performed between the two cohorts.

RESULTS

Of the 114 patients, pancreatic cancer was the most common malignancy (68/114, 60%), followed by cholangiocarcinoma (16/114, 14%). Stenosis or occlusion involved greater than one portomesenteric vein in the majority of patients (93/114, 82%). In the PVS cohort, stent deployment involved greater than one portomesenteric vein in most patients (32/38, 84%). Technical success for PVS was 95% (36/38), with no major or minor complications. In the non-stent cohort, 50% of patients (38/76) were treated with systemic anticoagulation, with 50% of patients unable to be anticoagulated due to history of bleeding and/or thrombocytopenia. While there was a significant decrease in serum albumin ($P < 0.01$) and platelet counts ($P = 0.01$) in the non-stent cohort at 6 months following the diagnosis of PVO, albumin ($P = 0.4$) and platelet levels ($P = 0.8$) were maintained in the PVS cohort after stenting. There was also a significant increase in the proportion of non-stent patients with symptomatic ascites ($P < 0.001$) following PVO diagnosis compared to a significant decrease in the PVS group ($P < 0.01$). There was a significant increase in survival amongst the PVS cohort ($P = 0.02$).

CONCLUSION

In appropriately selected cancer patients with PVO, PVS can reduce the development of ascites, maintain platelet and albumin counts, and possibly increase survival.

CLINICAL RELEVANCE/APPLICATION

PVS is a safe, highly technically feasible intervention that improves clinical and serologic outcomes in cancer patients with PVO.

SSG17-04 Cross-Sectional Imaging (CSI) Findings Predict Clinically Significant Portal Hypertension (pHTN): Correlation with Direct Hepato-Portal Venous Gradient (HPVG) and Portosystemic Gradient (PSG) Manometry

Tuesday, Nov. 28 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

To investigate the prognostic value of CSI findings of pHTN through correlation with direct HPVG and PSG manometry values.

METHOD AND MATERIALS

IRB approved HIPAA compliant study of 100 consecutive patients (Mean age 55.4 [20-77] yrs, 44% female, 56% male) with suspected pHTN who underwent transjugular liver biopsies from Nov 2014 to Nov 2016. PSGs (difference between right atrial and wedge pressures) and HPVGs (difference between free hepatic and wedge pressures) were recorded for all cases. CT and MRI were used to record secondary signs of pHTN (i.e., hepatic hydrothorax, ascites, varices, umbilical vein recanalization, venous shunts) and measure liver, spleen, left renal, and main portal vein diameters. Overall liver morphologies were noted. Portal venous flow direction was confirmed with Doppler. Each variable was correlated with PSGs and HPVGs. Pressure gradients >5 mmHg defined pHTN, while >=10 mmHg defined clinically significant pHTN. Characteristic differences between groups were compared using Chi-Square utilizing SPSS software v20.0 (IBM, Armonk, NY). Significance was set at <0.05.

RESULTS

Of the 100 subjects, 90% had pHTN (30% alcohol-related, 19% Hep C, 3% Hep B, 9% NASH, 29% cryptogenic), 10% had normal pressures, and 70% had stage III/ IV fibrosis. Average PSG was 17 mmHg (s=9), while the average HPVG was 13 mmHg (s=8). Variables predicting a PSG >10 mmHg included hepatofugal flow (p=0.000), liver diameter <15 cm (p=0.034), spleen >11 cm (p=0.029), hydrothorax (p=0.004), ascites (p=0.000), esophageal varices (p=0.000), gastric varices (p=0.006), perisplenic varices (p=0.031), omental varices (p=0.001), recanalized umbilical vein (p=0.029), gastrorenal shunt (p=0.000), and an IMV to superior rectal shunt (p=0.023). Variables predicting HPVG >10 included a hepatofugal flow (p=0.000), liver diameter <15 cm (p=0.047), spleen >11 cm (p=0.002), hydrothorax (p=0.018), ascites (p=0.001), esophageal varices (p=0.001), gastric varices (p=0.006), perisplenic varices (p=0.002), omental varices (p=0.000), recanalized umbilical vein (p=0.001), gastrorenal shunt (p=0.001), and an IMV to superior rectal shunt (p=0.017).

CONCLUSION

CSI findings can predict clinically significant pHTN and may thus guide patient prognosis and clinical decision-making for specific associated pathologies.

CLINICAL RELEVANCE/APPLICATION

Specific findings on CSI reliably correspond to PSGs and HPVGs, can predict clinically significant pHTN, and may justify forgoing additional invasive interventions.

SSG17-05 Hepatofugal Flow in the Main Portal Vein Prior to Transjugular Intrahepatic Portosystemic Shunt (TIPS) as a Predictor for Post-TIPS Variceal Embolization in Patients with Gastrointestinal Bleeding

Tuesday, Nov. 28 11:10AM - 11:20AM Room: E351

Participants
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PURPOSE

To investigate whether hepatofugal flow (HF) in the main portal vein (MPV) prior to transjugular intrahepatic portosystemic shunt (TIPS) creation can serve as a predictor for post TIPS variceal embolization in patients with gastrointestinal (GI) bleeding.

METHOD AND MATERIALS

A retrospective review of consecutive patients with GI bleeding who underwent TIPS from 1/2007 to 1/2017 was conducted. Pre-

and post-TIPS portosystemic pressure gradients and embolization of varices were reviewed. The directionality of the blood flow in the MPV prior to TIPS creation was determined to be HF or hepatopedal (HP) by a fellowship trained interventional radiologist blinded to the purpose of this study. Variceal embolization data was analyzed using the Fisher's exact test and mean post-TIPS portosystemic pressure gradients was analyzed using the student's T -test. A P value less than 0.05 was considered statistically significant.

RESULTS

40 patients were identified. The predominant causes of cirrhosis were hepatitis C and alcohol abuse. 24 patients demonstrated HP flow and 16 patients had HF flow. Of the 24 patients with HP flow, 6 patients (25%) required coil embolization post TIPS. This is compared to the 10 out of 16 patients (62.5%) with HF flow who underwent post-TIPS embolization, (p = 0.0245). Post TIPS portosystemic pressure gradient in the HP group was 6 mm Hg compared to 8 mm Hg (p = 0.058). Pre-TIPS portosystemic pressure gradient was not significantly different between the two groups.

CONCLUSION

In the setting of GI bleeding, HF blood flow in the MPV prior to TIPS creation may serve as a predictor for requiring post-TIPS variceal embolization.

CLINICAL RELEVANCE/APPLICATION

Pre-TIPS portograms are an essential part of imaging required for measuring the length of the shunt. Our group continues derive as much information from this imaging study, including consistent markers, that can be used best prepare Interventional Radiologists prior to TIPS procedures. In this study, we have demonstrated an association between the presence of HF flow on pre-TIPS portograms and the probable need for coil embolization in-TIPS procedure. Of course, larger scale studies are required to validate the data, including prospective randomized trials. In addition, we have shown a possible trend between HF flow demonstrated on pre-TIPS imaging predicting a post-TIPS pressure gradient of 6 mm Hg or more. Further data is required to validate this trend.

SSG17-06 Large Spontaneous Portosystemic Shunts in Therapy-Refractory Cirrhotic Patients: A Clear Definition of Risks and Tricks of Endovascular Management

Tuesday, Nov. 28 11:20AM - 11:30AM Room: E351

Participants
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PURPOSE

This study aimed to analyze the efficacy and safety of embolization of large spontaneous portosystemic shunts (SPSS) in cirrhotic patients with recurrent hepatic encephalopathy (HE).

METHOD AND MATERIALS

From February 2002 to January 2017, a prospective study of chronic therapy-refractory HE patients who underwent SPSS embolization was performed. Inclusion criteria: refractory chronic HE (recurrent episodes of HE without known precipitant and >=2 hospital admissions because of HE after the start of standard therapy), exclusion criteria: absence of cirrhosis, surgical shunt or TIPS graft, portal vein thrombosis, preexisting hepatocellular carcinoma, Child-Pugh class C13. Analysis and outcome parameters: baseline characteristics, diagnostic workup, therapeutic method, clinical and radiological outcomes.

RESULTS

Forty consecutive patients were found eligible according to inclusion and exclusion criteria. Mean age at treatment was 62.5±13.9, 55.0% male. Chronic liver damage: alcoholic abuse (36.7%), HCV (23.4%), cryptogenic (20.0%), non-alcoholic steatohepatitis (13.3%), primary biliary cirrhosis (3.3%), autoimmune hepatitis (3.3%). Prior to embolization, five patients had liver transplants. SPPS characterization: Doppler-Color Ultrasound, CT-Angiography, indirect Portography. SPSS types: spleno-renal (68.4%), meso-caval/renal (15.8%), gastro-acygos/renal (10.5%), recanalized para-umbilical veins (5.3%). Approaches: common femoral vein (60.0%), internal jugular vein (30.0%), transhepatic (6.7%), transplenic (3.3%). Materials: coils (28.5%), occlusion devices (25.0%), liquid agents (7.2%), combination (39.3%). Secondary procedures were performed in four patients after identification of revascularized SPSS. Follow-up range: 3-31 months. All patients improved autonomy and decreased severity of the worst HE episode. One patient had transient low cardiac output due to acute shunt-closure. There were no other procedure-related complications, portal hypertensive gastropathy or varices development.

CONCLUSION

SPSS embolization is an effective and safe complementary or curative treatment for HE persistence in cirrhotic patients, even after liver transplantation, improving quality of life by reduction of hospitalizations.

CLINICAL RELEVANCE/APPLICATION

The presence of large SPSS provides an explanation for hepatic encephalopathy persistence in cirrhotic patients and represents a therapeutic target in chronic medically refractory HE patients.

SSG17-07 Non-Invasive Pressure Monitoring After Transjugular Intrahepatic Portosystemic Shunt Implantation with Integrated Stent-Graft

Tuesday, Nov. 28 11:30AM - 11:40AM Room: E351

Participants
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PURPOSE

In vitro and ex vivo testing of a novel stent-graft with integrated pressure sensors capable of wirelessdigital data transmission for non-invasive pressure monitoring after TIPS.

METHOD AND MATERIALS

Ten stent-grafts for TIPS-implantation (100x10 mm) were designed including integrated pressure sensors at both ends within layers of polytetrafluorethylen (PTFE). Digital data conversion could be performed by integrated microcontrollers within the PTFE-membrane providing energy and datatransfer by inductive coupling. The stent-grafts were placed in a silicone liver phantom and in explanted porcine livers via 16F applicators.

RESULTS

First in vitro and ex vivo testing demonstrated a capable TIPS stent-graft design with integrated sensors in a stable PTFE-covering after crimping and application into a liver phantom and 4 porcine livers. In both setups measurements were simultaneously taken from the two sensors with an accuracy of ±1.2 mmHg up to a distance of 10 cm in a liver phantom and a distance of 8 cm in a porcine liver.

CONCLUSION

First in vitro and ex vivo results demonstrate a successful approach for non-invasive pressuremonitoring after TIPS by integrated sensors within a PTFE-cover. Further in vivo tests are required before the potential implementation into a product.

CLINICAL RELEVANCE/APPLICATION

Non-invasive pressure acquisition after TIPS via integrated sensors with the PTFE-membrane provides a suitable and precise way of monitoring patency.

SSG17-08 Clinical Significance of Abnormal findings on Baseline Transjugular Intrahepatic Portosystemic Shunt Doppler Sonography

Tuesday, Nov. 28 11:40AM - 11:50AM Room: E351

Participants
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PURPOSE

Doppler Sonography (DS) is frequently performed as a screening and diagnostic modality to evaluate the transjugular intrahepatic portosystemic shunt (TIPS). However, the clinical significance of initial frequently observed abnormalities of flow velocities, gradient and flow direction on baseline DS is less studied.

METHOD AND MATERIALS

A retrospective study was performed at a large referral center between 2002 and 2010 and all patients undergoing TIPS procedure for the management of portal hypertension (PHTN) were initially included. Patients without sufficient medical records or US examinations were excluded. Electronic medical records were reviewed and baseline DS findings as well as clinical data regarding recurrent symptoms of portal hypertension, and findings of TIPS angiography/revision studies were recorded. Abnormal DS indices were defined as peak intra-shunt velocities (PSV) <90 or >190 cm/sec, intra-shunt gradient >50 cm/s and abnormal flow direction in main, right or left portal veins.

RESULTS

195 patients underwent TIPS during the study period. 34 patients were excluded due to lack of clinical or sonographic follow up. Indication for TIPS was uncontrolled ascites in 95 (59%) and bleeding secondary to PHTN in 66 patients (41%). Median follow up was 24.6 months. During follow up period, PHTN symptoms recurred in 37 patients out of which 33 patients underwent TIPS angiography/revision. With regards to baseline US, Low PSVs were present in 54 (33.5%), normal PSVs in 96 (59.6%) and high PSVs in 9 patients (5.6%) while in 2 patients shunts were occluded. There was significantly lower rate of stenosis diagnosed on TIPS angiography/revision in patients with baseline low velocity PSVs (2/10 (20%) in patients with low PSVs compared to 14/21 (66.7%) and 1/2 (50%) in patient with normal and high baseline PSVs, p-value=0.02). There was no significant relationship between presence of abnormal intra-shunt gradient or abnormal flow direction on baseline DS and development of stenosis during follow up (p>0.05).

CONCLUSION

These findings suggest that in the absence of clinical findings of shunt failure, abnormal findings on baseline TIPS DS have low yield

for predicting development stenosis and recurrent PHTN.

CLINICAL RELEVANCE/APPLICATION

In the absence of other indicators of portal hypertension and shunt failure, abnormal findings on TIPS baseline DS may be safely observed without need for immediate invasive procedures.

SSG17-09 Delineation of Hepatic Veins: Comparison of Magnetic Resonance Angiography Using Spatial Labeling with Multiple Inversion Pulses, Perfusion-Weighted Imaging and Computer Tomography Angiography

Tuesday, Nov. 28 11:50AM - 12:00PM Room: E351

Participants
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PURPOSE

To evaluate and compare the visualization of hepatic veins by non-contrast-enhanced magnetic resonance angiography (MRA) using spatial labeling with multiple inversion pulses (SLEEK) with magnetic resonance perfusion-weighted imaging (PWI) and computer tomography angiography (CTA).

METHOD AND MATERIALS

SLEEK-MRA and CTA were performed on 20 patients with liver diseases. For visualization of hepatic veins, one inversion pulse was placed to cover the heart to suppress the signal in the hepatic artery, while the other beneath the bottom edge of liver to suppress the inflow signal of portal system. Subsequently 9 of the patients were examined with PWI. The visualization quality score of hepatic veins was scored on a four-point scale for assessment of left hepatic vein (LHV), middle hepatic vein (MHV) and right hepatic vein (RHV). On the original images of SLEEK-MRA, PWI and CTA, regions of interest were placed in LHV, MHV, RHV and homogenous liver parenchyma to acquire signal intensity and standard deviation. Contrast ratio (CR) of vessels to liver parenchyma, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. The visualization quality was analyzed with Wilcoxon signed-rank test. The CR, SNR and CNR were analyzed with paired t-test. A p value of <0.05 was considered statistically significant.

RESULTS

Compared to CTA, SLEEK-MRA revealed significantly higher visualization quality score, SNR, CNR and CR in MHV (3.2±0.6 vs 2.1±1.0, 37.3±10.2 vs 6.3±1.6, 19.1±9.1 vs 1.5±0.5, 2.1±0.5 vs 1.3±0.1) and RHV (3.0±0.7 vs 2.1±1.0, 36.3±7.5 vs 6.5±1.6, 18.2±5.6 vs 1.7±0.8, 2.0±0.3 vs 1.4±0.2)($p<0.01$), while significantly higher SNR, CNR and CR in LHV (32.1±8.6 vs 6.2±1.8, 12.9±6.7 vs 1.5±0.8, 1.7±0.3 vs 1.3±0.1)($p<0.01$). Compared to PWI, SLEEK-MRA revealed significantly higher CNR and CR in LHV (11.2±4.0 vs 6.0±3.8, 1.6±0.2 vs 1.2±0.2) and MHV (18.3±8.7 vs 7.3±2.6, 2.0±0.4 vs 1.3±0.1)($p<0.01$), as well as in RHV (16.7±6.4 vs 9.3±2.9, 1.9±0.3 vs 1.4±0.2)($p<0.05$). No statistically significant difference was found for visualization quality score and SNR in hepatic veins.

CONCLUSION

SLEEK-MRA visualizes hepatic veins in high quality and better contrast than traditional contrast-enhanced CTA and PWI.

CLINICAL RELEVANCE/APPLICATION

SLEEK-MRA provides a method to selectively delineate hepatic veins with high image quality and contrast to the liver background, while free from exogenous contrast media.

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SSJ01

Breast Imaging (Tomosynthesis Screening Applications)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: Arie Crown Theater

BR OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Debra S. Copit, MD, Philadelphia, PA (*Moderator*) Grant, Hologic, Inc
Priscilla J. Slanetz, MD, MPH, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ01-01 Breast Cancer Screening with Tomosynthesis Detects More Cancers: Final Results of 14,848 Women in a Prospective, Population-Based Screening Trial

Tuesday, Nov. 28 3:00PM - 3:10PM Room: Arie Crown Theater

Participants
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PURPOSE

To assess one-view digital breast tomosynthesis (DBT) and a combination of one-view DBT and one-view digital mammography (DM) compared to two-view DM in population-based screening.

METHOD AND MATERIALS

This is a prospective, one-arm, single-institution, population-based screening trial involving 14,848 women aged 40-74 years randomly invited from the service screening programme in an urban area, Jan 2010-Feb 2015. Women underwent one-view DBT (mediolateral oblique view) with reduced compression force and two-view DM at one screening occasion. Images were read in two separate reading arms (DBT reading arm and DM reading arm) with independent double reading and scoring. The reading sequence in the DBT arm was: 1. one-view DBT; 2. one-view DBT + cranio-caudal view of DM; 3. addition of prior two-view DM if available. McNemar's test with 95 % confidence intervals was used to compare detection and recall rates.

RESULTS

In total, 137 women had screen-detected cancers in the trial (one bilateral case). Eighty-eight of the cases were detected with both DBT and DM, 41 were detected only in the DBT reading arm and eight only in the DM reading arm. The breast cancer detection rate was 8.7/1000 screened women in the DBT reading arm (95% CI: 7.3-10.3) and 6.5/1000 screened women in the DM reading arm (95% CI: 5.2-7.9). The relative increase in cancer detection in the DBT reading arm vs. DM was 34.4% (95% CI: 18.8-52.0, $p<0.001$). All but two cancers in the DBT reading arm were detected in the first reading step, i.e. one-view DBT alone. The recall rate after arbitration in the DBT reading arm was 3.6% (95% CI 3.3-3.9) and for the DM reading arm 2.5% (95% CI 2.2 -2.8), a statistically significant increase, $p<0.001$.

CONCLUSION

Breast cancer screening using one-view DBT with reduced compression increases cancer detection significantly at a reasonable recall rate and seems to be a feasible screening strategy.

CLINICAL RELEVANCE/APPLICATION

It is a well-recognized fact that DM has its limitations as a stand-alone screening modality. DBT represents an advancement of the mammographic technique. The results of the current trial indicate that DBT as a stand-alone screening modality is feasible and the reduced compression force may represent a further benefit potentially encouraging more women to attend screening.

SSJ01-02 Detection of Ductal Carcinoma in Situ in the Experimental Arm of a Trial Comparing Tomosynthesis plus Digital Mammography vs Digital Mammography

Tuesday, Nov. 28 3:10PM - 3:20PM Room: Arie Crown Theater

Participants
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PURPOSE

While higher sensitivity for invasive cancers of tomosynthesis (DBT) compared to digital mammography (DM) has been showed in many studies, there are inconsistent results if DBT is more sensitive than DM in detecting ductal carcinoma in situ (DCIS). Here we present the results of detection of DCIS in the preliminary analysis of the RETomo trial by arm and imaging results.

METHOD AND MATERIALS

Women (45-70yo) presenting for a screening mammography in Reggio Emilia, were asked to participate and, if willing, randomized to the experimental arm (DBT+DM), or to the control arm (DM), both with double reading. Results of the DBT alone were recorded separately, but women were managed according to the joined evaluation DBT+DM (NCT02698202). Relative detection rate of DCIS in the experimental arm compared to control arm is reported; DCIS detected in the experimental arm are presented in detail by results of DBT alone and DBT+DM. Images with discordant DBT and DBT+DM reports were submitted to informed review by a third independent radiologist.

RESULTS

From March 2014 to March 2016 approximately 19637 women were recruited, 9854 in the experimental arm. The overall detection rate was 8.2/1000 and 4.5/1000 in the experimental and control arm respectively (relative detection rate 1.83, 95% confidence interval (CI) 1.26-2.64). DCIS were 14 and 5 in the experimental and control arm respectively (relative DCIS detection 2.85, 95%CI 1.03-7.90). Six out of 14 DCIS of the experimental arm were reported as negative by both readings, while were recalled when DM was analysed together with DBT. Among invasive cancers in the experimental arm, only 2 out of 65 were negative to both DBT readings. The post-hoc informed revision showed that DBT-negative DCIS were visible as microcalcifications. Only the comparison of DM with previous screening mammograms led to suspect of malignancy.

CONCLUSION

DBT+DM increases the detection of DCIS compared to DM alone. In a low prevalence setting where low recall rate is pre-fixed target for readers, the identification of DCIS needs careful evaluation of priors to pose the suspect of malignancy.

CLINICAL RELEVANCE/APPLICATION

DBT+DM increases the detection of DCIS compared to DM alone, but, in the evaluation of microcalcifications, to pose the suspect of malignancy 2D images for comparison are needed.

SSJ01-03 Screening Mammography Findings from One Standard Projection Only in Era of Full Field Digital Mammography and Tomosynthesis

Tuesday, Nov. 28 3:20PM - 3:30PM Room: Arie Crown Theater

Participants
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PURPOSE

To compare outcomes of findings seen on one view only from full-field digital screening mammograms (FFDM) and FFDM with tomosynthesis (FFDM-DBT).

METHOD AND MATERIALS

An IRB-approved, HIPAA-compliant retrospective review was performed of 103,070 consecutive screening mammograms obtained from February 2011 through June 2014 at two community-based breast centers. Recalled findings prospectively seen on one view only were analyzed. Pearson's chi-squared test and Fisher's exact test were performed, and 95% CIs were determined.

RESULTS

The study included 71,656 FFDM and 31,414 FFDM-DBT. Overall, 5641 of the 71,656 FFDM (7.9%) and 1914 of the 31,414 FFDM-DBT (6.1%) were recalled, and 2213 of the recalled FFDM and 433 of the recalled FFDM-DBT revealed findings on only one view. 689 FFDM and 92 FFDM-DBT were excluded for insufficient mammographic follow-up(<24 months). Significantly more FFDM than FFDM-DBT had a one-view-only finding (3.1% vs 1.4%; p<0.0001). Summation artifacts accounted for more one-view-only findings from FFDM (1067 of 1592, 67.0%) than FFDM-DBT (190 of 354, 53.7%) (p<0.0001). In the FFDM cohort, 28 one-view-only findings proved malignant (24 invasive ductal carcinoma [IDC], 1 invasive lobular carcinoma [ILC], 3 ductal carcinoma in situ [DCIS]). In the

FFDM-DBT cohort, 14 one-view-only findings proved malignant (11 IDC, 1 ILC, 2 DCIS). The positive predictive value (PPV) of a one-view-only finding was significantly lower for FFDM (1.76%) than FFDM-DBT (3.95%) (p=0.010).

CONCLUSION

One-view-only screening mammography findings that prompt recall are more frequent, are more likely to represent summation artifacts, and have a lower PPV with FFDM than with FFDM-DBT.

CLINICAL RELEVANCE/APPLICATION

One-view-only findings are not uncommonly recalled at screening mammography, and to our knowledge, their outcomes have not been analyzed since the advent of digital imaging. Radiologists should be aware of the differences between one-view-only findings from FFDM versus FFDM-DBT and apply this to clinical practice.

SSJ01-04 Radiation Dose from Tomosynthesis and Digital Mammography versus Quantitative Breast Density

Tuesday, Nov. 28 3:30PM - 3:40PM Room: Arie Crown Theater

Participants
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PURPOSE

To compare radiation dose by digital breast tomosynthesis (DBT) and digital mammography (FFDM) counting for breast density.

METHOD AND MATERIALS

4764 breast paired views (cranio-caudal, CC, and medio-lateral oblique, MLO) were obtained by the same acquisition system with DBT and FFDM, keeping the same breast compression (COMBO mode) and using the automatic exposure mode. Raw images were processed to compute volumetric breast density. Mean glandular dose (MGD) was calculated for both image modalities, according to the model proposed by Dance, using breast density (BD) to adjust the estimated MGD. Quantitative breast density values were groupped in four categories (A, B, C, D) and MGD of DBT and FFDM was compared for each BD class. The dose ratio was determined by dividing MGD DBT by MGD FFDM dose for each pair.

RESULTS

The mean MGDs for the four breast density categories (A, B, C, D) were higher with tomosynthesis than mammography (DBT: 3.062, 2.551, 1.832, 1.430 mGy, DM: 1.900, 1.721, 1.365, 1.121 mGy),. DBT dose correlates differently with FFDM dose, depending on the breast density class. The mean dose ratio (DBT/FFDM) was 1.617 for breast density class A, 1.495 for class B, 1.375 for C, and 1.305 for D, showing that tomosynthesis dose increase compared to mammography is higher for fatty breasts than for dense breasts.

CONCLUSION

Radiation dose per-view is higher with tomosynthesis compared to mammography. Dose increase is higher for fatty breasts and lower for dense breasts.

CLINICAL RELEVANCE/APPLICATION

Digital breast tomosynthesis radiation dose is slighly higher than digital mammography. The increase is lower for dense breasts.

SSJ01-05 Digital Breast Tomosynthesis Cancer Screening versus Full Field Digital Mammography Cancer Screening: Imaging and Pathological Features

Tuesday, Nov. 28 3:40PM - 3:50PM Room: Arie Crown Theater

Participants
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PURPOSE

To evaluate imaging characteristics, size, grade, type, node status and biological features of cancers detected by digital breast tomosynthesis plus synthesized 2D images (DBT+synt2D) in a breast cancer screening program, compared with those found with full-field digital mammography (FFDM).

METHOD AND MATERIALS

All consecutive breast cancers diagnosed in 16666 women screened by DBT+synt2D (April 2015 to March 2016; DBT group) and in 14423 women screened by FFDM (April 2014 to March 2015; FFDM group) were retrospectively reviewed. Radiological characteristics, cancer size, grade, type (ductal, lobular, tubular, other), node status and biological features (oestrogen and progesterone receptors, Ki-67, HER2/neu) were compared between the two groups.

RESULTS

Cancer detection rate (CDR) was 9.78/1000 in DBT group versus 5.34/1000 in FFDM group (RR 1.83, 95% CI 1.40-2.40). DBT findings included opacity in 68.1% (versus 58.4% at FFDM) and architectural distortion in 9.2% of cases (versus 2.6% at FFDM) (p=0.029). The CDR for invasive cancers was 8.58/1000 in DBT group versus 4.02/1000 in FFDM group (p=0.01). The size of invasive cancers was significantly smaller in DBT group versus FFDM group (median 13.4 mm vs 16.4 mm, p=0.001). More low-grade invasive cancers were detected in DBT group versus FFDM group: 31.9% versus 11.7%, respectively (p=0.01). No differences were found in cancer type (p=0.224), with a prevalence of invasive ductal carcinoma in both groups (63.8% and 59.7%, respectively). Node status was similar between the two groups (p=0.091). More HER2 negative cancers were detected in DBT group (91.6%) versus FFDM group (79.3%; p=0.01) while no differences were found in oestrogen and progesterone receptors expression and in the Ki67 proliferation index (p>0.05).

CONCLUSION

Breast cancer screening with DBT+synt2D increases overall breast cancers detection, with a preferential increase in the detection of invasive cancers, improving visualization of opacities and architectural distortions. Additional breast cancers found are more likely to be smaller, low-grade, ductal type and HER2 negative, with important prognostic and predictive implications.

CLINICAL RELEVANCE/APPLICATION

The analysis of cancers detected by DBT has prognostic and treatment significance and could be the initial step to address concerns about DBT contributing to overdiagnosis.

SSJ01-06 Comparing Two Visualization Protocols for Tomosynthesis in Screening: Specificity and Sensitivity of Slabs vs Slabs plus Planes

Tuesday, Nov. 28 3:50PM - 4:00PM Room: Arie Crown Theater

Participants
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PURPOSE

There is growing evidence that tomosynthesis (DBT) is more sensitive than digital mammography (DM), but its introduction in screening is limited by longer reading times. Simplified visualization protocols have been designed to reduce reading time. In this study we compared the accuracy of simplified protocol with slab (1 cm thickness, overlapped 0.5 cm) alone vs. a standard protocol of slab plus planes (1 mm thickness, continuous). Both were integrated with synthetic-2D (Sy2D).

METHOD AND MATERIALS

Two expert screening radiologists retrospectively examined 906 randomly selected DBT from the RETomo screening trial experimental arm, where women received DBT+DM. Only women that were positive at the screening reading were assessed for cancer. All the DBT were read by both radiologists with both protocols after 3 months wash-out period. The order of reading was randomly assigned to have half of the sample read before with simplified and half with standard protocol. We present sensitivity, specificity and kappa values for inter-reader agreement.

RESULTS

Among the 906 women, 24 were recalled and 12 had a cancer (including 2 in situ). With the simplified protocol readers correctly classified as positive 15 out of 24 readings of women with cancer: 4 cancers were missed by both readers and one by only one, for a total of 9 false negative readings (sensitivity 63%, 95% confidence interval (CI) 41-81); 20 in the standard protocol (sensitivity 83%, 95%CI 62-95) (p=0.1). Among women who did not have evidence of cancer, the simplified protocol correctly classified as negative 1727 out of 1788 readings (specificity 96.6%, 95%CI 95.6-97.4); the standard protocol correctly classified 1699 readings (specificity 95.0%, 95%CI 93.9-96.0) (p=0.006). Inter-reader agreement was 0.53 and 0.36 with simplified and standard protocol, respectively.

CONCLUSION

A simplified protocol (Sy2D+slabs) increased the specificity and reproducibility of reading in a screening population, but had a negative impact on sensitivity. The study will be completed with the analysis of a DBT set enriched of cases in order to have a more precise estimate of sensitivity.

CLINICAL RELEVANCE/APPLICATION

To overcome the longer reading time for DBT in screening, a simplified protocol (synthetic2D+slabs) increased the specificity and reproducibility of readings, but with negative impact on sensitivity.

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103rd Scientific Assembly and Annual Meeting
November 26 to December 1
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SSJ02

Breast Imaging (Ultrasound Advanced Applications)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E450A

BR US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants

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Sub-Events

SSJ02-01 Predictive Models for Contrast-Enhanced Ultrasound of the Breast: Is it Feasible, Does it Improve Imaging Reporting Performance and Data System Evaluation for Critical Breast Lesions? Primary Analysis from a Multi-Center Prospective Study

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E450A

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PURPOSE

To determine whether a predictive model for contrast-enhanced ultrasound (CEUS) of the breast can improve the precision of breast imaging reporting and data system (BI-RADS) categorization.

METHOD AND MATERIALS

A total of 730 patients with 742 solid breast lesions classified as BI-RADS 4 or 5 on conventional ultrasound and mammography were evaluated. CEUS was performed before core needle biopsy or surgical resection and a revised BI-RADS classification was assigned based on six predictive models for CEUS of malignant and benign breast lesions analyzed on 10 enhancing patterns. Receiver operating characteristic curve analysis was conducted to evaluate the diagnostic performance of CEUS-based BI-RADS assignment with pathological examination as reference criteria.

RESULTS

The CEUS-based BI-RADS evaluation classified 262/742 (35.31%) lesions into category 3, 43 (5.79%), 27 (3.64%), and 47 (6.33%) lesions into categories 4A, 4B and 4C, respectively, and 363 (48.92%) into category 5, compared with 276/742 (37.19%), 199 (26.82%), 93 (12.53%), and 172 (23.18%) in BI-RADS 4A, 4B, 4C, and 5 based on conventional ultrasound and mammography. Selecting CEUS-based BI-RADS category 3 as an appropriate cutoff resulted in accuracy, sensitivity, specificity, and positive and negative predictive values of 80.05%, 98.26%, 64.32%, 70.42%, and 97.71%, respectively, for the diagnosis of malignant disease. The cancer-to-biopsy yield was 64.3% with CEUS-based BI-RADS 3 selected as the biopsy threshold compared with 46.42% otherwise, while the biopsy rate was only 72.2% compared with 100% otherwise. Overall, only 1.74% of invasive cancers were misdiagnosed as BI-RADS 3, the category we use nowadays.

CONCLUSION

In our patient cohort, evaluation of BI-RADS 4 or 5 breast lesions with CEUS results in reduced biopsy rates and increased cancer-to-biopsy yield.

CLINICAL RELEVANCE/APPLICATION

CEUS can improve the BI-RADS with reduced biopsy rates and increased cancer-to-biopsy yield.

SSJ02-02 Correlation of Quantitative and Qualitative US Indexes of Tumor Vascularity with Histologic Vascular Parameters in Breast Masses: Superb Microvascular Imaging (SMI) and Contrast-enhanced US

(CEUS)

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E450A

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PURPOSE

To investigate the correlation between quantitative and qualitative ultrasound (US) indexes of tumor vascularity on Superb Microvascular Imaging (SMI) and contrast-enhanced ultrasound (CEUS) and histologic vascular parameters in breast masses.

METHOD AND MATERIALS

This prospective study was approved by the institutional review board and written informed consent was obtained. Ninety-eight suspicious solid breast masses (57 benign and 41 malignant) were examined by SMI and CEUS prior to biopsy. We used Aplio 500 US equipment (Toshiba Medical Systems Corporation, Japan) and SonoVue contrast agent (Bracco, Italy). Two radiologists analyzed quantitative and qualitative vascularity indexes of SMI (vascular index, vessel morphology, distribution, and penetrating vessel) and CEUS (time intensity curve parameters and enhancement pattern). Histological vascular parameters, including microvessel density and diameter, were measured. Histological parameters according to tumor type, grade, and hormone receptor were compared using t- and Mann-whitney test. Correlations analysis was performed between US indexes and histologic parameters using spearman's correlation and Kruskal-Wallis test with Bonferroni correction.

RESULTS

Microvessel density was significantly higher in malignant masses than benign masses and malignant masses with negative estrogen receptor or high grade had higher microvessel density than those with positive estrogen receptor or low grade ($P<.05$). Microvessel diameter was not different between benign and malignant masses ($P>.05$). Quantitative US indexes including peak intensity ($r=0.546$), slope ($r=0.462$) and area ($r=0.574$) on CEUS and vascular index ($r=0.634$) on SMI were correlated with microvessel density ($P<.01$ for all). Qualitative US indexes including enhancement degree, enhancement order, penetrating vessel, perfusion defect on CEUS and vessel morphology, distribution, penetrating vessel were significantly correlated with microvessel density ($P<.01$ for all).

CONCLUSION

Quantitative and qualitative US indexes of tumor vascularity on SMI and CEUS are significantly correlated with histologic microvessel density in the corresponding tumor region.

CLINICAL RELEVANCE/APPLICATION

US vascularity indexes on SMI and CEUS could be used as surrogate markers representing histologic tumor microvessel density and may be used for predicting tumor angiogenesis in the preintervention period.

SSJ02-03 Optoacoustic Imaging of the Breast: Down-classification and Up-classification of Suspicious Breast Masses

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E450A

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PURPOSE

Optoacoustics (OA/US) imaging is a new technology based on laser light excitation. Combined with gray scale ultrasound, it enables simultaneous assessment of functional and anatomical information that may improve distinction between benign and malignant masses of the breast. The aim of this study was to assess OA/US's sensitivity, specificity and its ability to downgrade benign masses and upgrade malignant masses in terms of probability of malignancy (POM) and BI-RADS category.

METHOD AND MATERIALS

In this prospective, multi-center study, compliant with ISO14155 and applicable laws and regulations, we report results of 209 patients with 215 breast masses classified as BI-RADS 4a or 4b by conventional diagnostic ultrasound (CDU). Patients were enrolled

between 2015 and 2016. Institutional review board approval and written informed consent were obtained. All masses were evaluated with OA/US prior to biopsy. For each mass, the radiologist scored 5 OA/US features, and then adjusted the POM and BI-RADS category. OA/US sensitivity, specificity, BI-RADS downgrade and upgrade percentages were assessed with the contribution from an estimator.

RESULTS

OA/US specificity improvement over CDU was 41.1%. OA/US sensitivity was 95.5%. With OA/US, 41.1% of benign masses classified as BI-RADS 4a or 4b were downgraded to BI-RADS 3 or 2 and 49.2% of malignant masses were upgraded in BIRADS category.

CONCLUSION

OA/US improves the distinction between benign and malignant masses compared to CDU alone. Benign masses (particularly those classified as BI-RADS 4a) may be downgraded to BI-RADS 3 or 2 with OA/US, potentially decreasing negative biopsies and short interval follow-up imaging exams.

CLINICAL RELEVANCE/APPLICATION

With OA/US, many benign masses classified as BI-RADS 4a with CDU may be downgraded to BI-RADS 3 or 2, offering the potential to decrease biopsies of benign lesions and short interval follow-up imaging exams.

SSJ02-04 Targeted Axillary Dissection: Challenges with Axillary Lymph Node Clip Placement, Clip Identification, and Clip Retrieval post Neoadjuvant Therapy

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E450A

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PURPOSE

Clinically node-positive breast cancer patients often receive neoadjuvant chemotherapy (NAC) which eradicates nodal disease in 40-70% of patients. Clip placement in biopsy-confirmed metastatic lymph nodes (LNs) allows for selective removal in addition to sentinel node removal after NAC as part of targeted axillary dissection (TAD). We report success rates of clip placement, clip identification, and clip retrieval in metastatic axillary nodes to facilitate TAD.

METHOD AND MATERIALS

A retrospective institutional review board approved study was performed of 2 cohorts of patients: 223 LNs in 222 patients with clip placement from October 1, 2011 to December 30, 2015 [cohort 1]; 100 LNs in 100 patients from January 1, to November 30, 2016 [cohort 2; changes were made to the ultrasound image capture protocol for the documentation of clipped lymph nodes after the first 5 years of performing this procedure that included measurement of distance from clip to skin in transverse and longitudinal planes at the time of placement]. Success rates of clip placement, clip identification, and clip retrieval, were compared with clinico-pathologic features in cohort 1, and also between the 2 cohorts.

RESULTS

Overall, clip placement failure occurred in 14/323 LNs (4.3%) and 9/310 (2.9%) clips were not identified on follow-up ultrasound. Of 223 clipped LNs that underwent radioactive seed placement, the clip and seed were successfully retrieved in the same LN in 215 (96.4%). In cohort 1, failure in clip identification was associated with larger number of abnormal lymph nodes at diagnosis, perinodal clip placement, thinner cortex after neoadjuvant therapy, and greater distance of node from skin. Clip location in the cortex was a significant predictor for clip retrieval. Cohort 2 had a higher rate of successful clip placement (99% vs 94.2%, p=.07) and clip identification (100% vs 90.1%, p=.0004) than cohort 1.

CONCLUSION

Optimal techniques for clip placement, that include location within the cortex and detailed imaging after placement, help to improve the ability to identify and retrieve clipped axillary nodes after NAC.

CLINICAL RELEVANCE/APPLICATION

While there are clinico-pathologic features (clip location in cortex) that impact clip placement, clip identification, and clip retrieval success, appropriate training in clip documentation at diagnosis can mitigate against these challenges.

SSJ02-05 Cancer Detection in Breast Ultrasound Using an Industrial Grade Deep Learning Image Analysis Software

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E450A

Participants
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PURPOSE

To train a generic deep learning software (DLS) for the diagnosis of breast cancer in ultrasound images and to compare the performance to human readers with variable breast imaging experience.

METHOD AND MATERIALS

In this IRB-approved, HIPAA compliant, retrospective study, all breast ultrasound examinations from one year were reviewed. Patients with scars, initially indeterminate, or malignant lesions with histological diagnoses or 2-year follow-up were included. The DLS was trained with 70% of the images, the remaining 30% were used to validate the performance. Three readers with variable expertise also evaluated the validation set (radiologist, resident, medical student). Diagnostic accuracy was assessed with a receiver operating characteristic (ROC) analysis. Interreader agreement was measured with the concordance correlation coefficient (CCC).

RESULTS

Eighty-two patients with malignant and 550 with benign lesions were included. Time needed for training was 7 minutes (DLS). Evaluation times were 3.7 seconds (DLS) and 28, 22 and 25 minutes for human readers (decreasing experience). ROC analysis revealed non-significant differences in the area under the curve of 0.84 (DLS), 0.88 (experienced and intermediate readers) and 0.79 (inexperienced reader). Interreader agreement was best between the two more experienced readers (0.56, 95% CI 0.45-0.67) and the DLS and the reader with intermediate experience (0.49, 0.38-0.59), respectively.

CONCLUSION

DLS can diagnose cancer in breast ultrasound images with an accuracy comparable to radiologists. DLS learns substantially better and faster than a human reader with no prior experience given the same amount of training data.

CLINICAL RELEVANCE/APPLICATION

Real-time heatmaps embedded in an ultrasound examination could increase the radiologists sensitivity to subtle or atypical cancerous lesions.

SSJ02-06 Quantitative Analysis of Contrast-Enhanced Ultrasound of Lymph Nodes: A Novel Technique to Detect Early Metastasis

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E450A

Participants
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PURPOSE

To evaluate whether quantitative analysis of contrast-enhanced ultrasound (CE-US) can predict early lymph node (LN) metastasis in clinically node-negative breast cancer.

METHOD AND MATERIALS

This prospective study was approved by the institutional review board and informed consent was obtained from participants. In total, 56 patients who had no swelling LN using conventional CT, MR or US imaging underwent CE-US before surgery. Microbubble (Sonazoid; 0.015 mL/kg) was injected as a bolus with a 10-mL saline flush and continuous 75 s DICOM images were obtained. Time intensity-curve analysis was used to quantitatively analyze CE-US images. A region of interest (ROI) was placed within each LN where the highest signal increase was observed on CE-US images to obtain the peak intensity of the maximum enhanced area (PImax). A ROI was placed where the lowest signal increase was observed to obtain peak intensity of the minimum enhanced area (PImin). To evaluate heterogeneity of enhancement in LNs, the PIratio was calculated: PIratio = PImax / PImin. For visual analysis, the presence of a perfusion defect in LNs was evaluated. PI ratios and visual analyses were compared between pathological positive- and negative-metastasis groups in breast cancer patients.

RESULTS

Fifteen patients were diagnosed histologically with positive LN metastases (median 4, range 2.5-12 mm) and the remaining 41 as negative. The PIratio was significantly higher in the positive-metastasis than in the negative-metastasis group ($p = 0.0073$). ROC analysis revealed that the most effective threshold of PIratio was 1.52 and the area under the curve was 0.74. Using this threshold, the sensitivity, specificity, PPV, and NPV were 53%, 93%, 73%, and 84%, respectively. No statistically significant difference was found in visual assessments between negative- and positive-metastasis groups ($p = 0.09$).

CONCLUSION

The PIratio in quantitative analysis of CE-US imaging may be useful for detecting the presence of early LN metastasis in clinically node-negative breast cancer.

CLINICAL RELEVANCE/APPLICATION

Quantitative analysis of CE-US imaging may be useful for detecting the presence of early lymph node metastasis and is recommended in the initial evaluation of lymph node status.

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SSJ03

Cardiac (Valve Disease)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S502AB

CA CT

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSJ03-01 Quantitative Assessment of Mitral-Valve Using a Pre-Interventional Software: A Comparison between Patients with Mitral Valve Prolapse and Healthy Subjects

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S502AB

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PURPOSE

To characterize adaptive changes in mitral annulus anatomy in patients with mitral valve prolapse as compared to healthy subjects using mitral valve characterization software and multiphase cardiac CT datasets.

METHOD AND MATERIALS

In this retrospective study, 50 patients with known mitral valve prolapse who had previously undergone retrospective ECG-gated cardiac CTA using 1st generation dual-source CT (SOMATOM Definition, Siemens Healthcare) were evaluated. The control group comprised of 50 patients without mitral-valve pathology who underwent retrospective ECG-gated coronary CTA on 2nd generation dual-source CT (SOMATOM Definition Flash, Siemens Healthcare). Thin section, multiphase axial images were loaded into prototype mitral valve characterization software on a dedicated post processing workstation (Syngo.via VA30, Siemens Healthcare). Using 16 seeding points, the program semi-automatically segmented the saddle-shaped mitral valve annulus, generating the following parameters: annulus circumference (AC), surface area (SA), distance between the right and left trigone (TT), distance between the anterior and posterior horn (AP), distance between anterolateral and posteromedial annulus point (ALPM), ratio of AP and ALPM defined as ellipticity (E). Computed parameters were compared between the two groups.

RESULTS

Except E(0.81 [0.67-0.93] vs. 0.82 [0.65-0.92], p = 0.44), all other parameters were significantly different between the prolapsed and non-prolapsed groups (p<.001) with circumference (144 [115-173] vs. 117 [99-144] mm), SA (1533 [935 - 2223] vs. 1005 [717 - 1496] mm2), AP (38.4 [29.6 - 46.7] vs. 31.5 [26.5 - 37.9] mm) and ALPM (47.3 [37.1 - 57.4] vs. 38.5 [32.6 - 49.4] mm) being most prominent. Values over a cardiac cycle were more stable in the non-prolapsed valves, with more variation across the cardiac cycle seen in patients with prolapsing mitral valves.

CONCLUSION

This mitral valve characterization tool can be used to distinguish between prolapsed and non-prolapsed valves by using a set of standardized, quantitative parameters that may have relevance for the design and implementation of catheter-deployed mitral valve prostheses.

CLINICAL RELEVANCE/APPLICATION

Quantitative assessment of the mitral valve will enhance diagnosis of mitral valve prolapse and has the potential to improve procedure planning by allowing patient-specific prosthesis selection.

SSJ03-02 The Association between Morphological and Functional Characteristics of Bicuspid Aortic Valve and Bicuspid Aortopathy

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S502AB

Participants
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PURPOSE

The aims of this study were to determine the association between morphological and functional characteristics of bicuspid aortic valve (BAV) and bicuspid aortopathy and to identify the determinants of aortic dilatation using cardiac computed tomography (CCT).

METHOD AND MATERIALS

This study cohorts included 282 subjects (206 men, age 52±15 years) who underwent both CCT and transthoracic echocardiography. BAVs were classified as anterior-posterior (BAV-AP) or lateral (BAV-LA) and divided according to the presence (raphe+) or absence of a raphe (raphe-) based on CCT findings. The sinuses of Valsalva and proximal ascending aorta were measured by CCT. Factors related to aortic root and ascending aorta diameter were evaluated by multiple linear regression analysis. The determinants of aortic root and proximal ascending aortic dilatation (size index >2.1 cm/m2) were assessed by multiple logistic regression analysis.

RESULTS

BAV-AP was present in 173 patients (61%) and raphe+ in 168 (60%). BAV morphotype and raphe+ or raphe- were not associate with aortic root and ascending aortic diameters. The aortic root diameter were significantly associated with aortic stenosis (AS) severity (estimate -1.87, p=0.02) and sex (estimate -2.77, p<0.01) and the ascending aorta diameter with age (estimate 0.14, p<0.001). Patients with dilated aortic root (n=207) were older (p=0.02) and had a lower prevalence of male sex (p<0.03) and lower body surface area (BSA, p<0.001). Patients with dilated ascending aorta (n=217) were older (p<0.001) and had lower prevalence of male sex (p<0.001), lower BSA (p<0.001), higher prevalence of hypertension (p=0.04), raphe+ (p=0.017), BAV-LA (p=0.04), moderate-to-severe AS (p<0.001) and none or mild aortic regurgitation (p<0.001). BSA was the sole independent determinant of aortic root diameter (p<0.001). Independent determinants of ascending aortic diameter were age (p<0.001), New York Heart Association class (p=0.01), BSA (p<0.001), and AS severity (p=0.003).

CONCLUSION

BAV morphotype and presence or absence of raphe are not associated with aortic root and ascending aortic dilatation and not the determinants of aortic dilatation. Further studies are needed to investigate the discrepancy in the importance of BAV morphotype predicting phenotypes of bicuspid aortopathy.

CLINICAL RELEVANCE/APPLICATION

Morphological characteristics of BAV may not have a direct impact on clinical outcomes and management plan for BAV-associated aortopathy.

SSJ03-03 Aortic Annulus Sizing in Bicuspid and Tricuspid Aortic Valves Using CT: Comparison with Surgically Replaced Prosthetic Valve Size in 667 Patients

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S502AB

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PURPOSE

Controversy exists regarding measurement of bicuspid aortic annulus diameter on computed tomography. Although we routinely measure bicuspid aortic annulus size similar to the method for tricuspid aortic valve (AV) prior to aortic valve replacement (AVR) or transcatheter aortic valve implantation (TAVI), there has been no study to validate the method for bicuspid valve.

METHOD AND MATERIALS

Annular measurements (maximal diameter, mean diameter, area-derived diameter, and perimeter-derived diameter) were performed in 667 (362 tricuspid, 166 bicuspid with raphe and 139 bicuspid without raphe) patients who underwent surgical AVR between June 2011 and Mar 2016. The differences between CT measurements and prosthetic AV sizes were evaluated. To find factors to affect the differences between CT diameters and prosthetic AV size, patients with 10% more larger diameter (n=421) on CT from the prosthetic AV size were compared with those within 10% range.

RESULTS

Bicuspid AV parameters were well correlated with prosthetic AV size as well as tricuspid AV parameters. The most representative measurements correspond to prosthetic AV size were area-derived diameter in tricuspid (r=0.69, p<0.001) and bicuspid AV without raphe (r= 0.73, p<0.001), and perimeter-derived diameter in bicuspid AV without raphe (r=0.65, p<0.001). In multivariable linear regression analysis, prosthetic AV size could be suggested using both area-derived diameter and sinus diameter (r2=0.59, p<0.001). The difference between CT-derived diameter and prosthetic AV size is affected by prosthetic valve types (OR 9.5; 95%CI 4.0-22.4; p<0.001), surgeons (OR 2.5; 95%CI 1.1-5.5; p=0.03), sex (OR, 3.5; 95%CI 2.0-6.2; p <0.001) and area-derived diameters (OR, 2.0; 95%CI 1.7-2.3; p<0.001) in multivariate logistic regression analysis. Area-derived diameter and sex were remained after adjusting the effects of prosthetic valve types and surgeon factors (p<0.01). Bicuspid AV did not affect the differences between CT diameters and prosthetic AV sizes.

CONCLUSION

Bicuspid AV diameters measured on CT showed good correlation with prosthetic AV size as well as tricuspid AV parameters. The difference between CT-derived diameter and prosthetic AV size is affected by prosthetic valve types, surgeons, sex, and CT-derived diameters.

CLINICAL RELEVANCE/APPLICATION

CT is useful for AV sizing including bicuspid AV, and this information could be important to select optimal valve size for both surgical AVR and TAVI.

SSJ03-04 Utility of Cardiac CT for Preoperative Evaluation for Mitral Regurgitation: Localization of Mitral Valve Prolapse and Prediction of Repairability

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S502AB

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PURPOSE

We aimed to investigate the diagnostic accuracy of dual-source cardiac computed tomography (CT) for detection of the prolapsed segment in mitral regurgitation (MR) and for prediction of non-repairable mitral valve (MV) with surgical finding as standard reference.

METHOD AND MATERIALS

A total of 85 patients with severe MR who underwent preoperative cardiac CT before MV surgery (MV replacement or repair) were retrospectively enrolled. The prolapsed segment of MV was assessed using Carpentier classification. Non-repairable MV was defined when met one of followings: 1) anterior leaflet prolapse, 2) bi-leaflet prolapse, 3) severe thickening and/or calcification of leaflets. Diagnostic performance of CT for the detection of prolapsed segment was assessed per patient, per leaflet (anterior or posterior) and per segment, with surgical findings as the standard reference. Diagnostic performances of CT for the prediction non-repairable MV was assessed and compared between each criteria for non-repariable MV by area under the curve (AUC) of receiver operating characteristics curve.

RESULTS

On the surgical field, MV prolapse was identified in 73.5%, and the most common segment was P2 (n=23). The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy for detection of MV prolapse were 98.4% (60/61), 72.7% (16/22), 80.8% (60/66), 81.0% (16/17) and 91.6% (76/83) per patient, 97.2% (69/71), 94.7% (90/95), 93.2% (69/74), 97.8% (90/92) and 95.8% (159/166) per leaflet and 79.6% (74/93), 92.6% (375/405), 71.2% (74/104), 95.2% (375/394) and 90.2% (449/498) per segment. Forty-seven patients met the criteria of non-repairable MV by CT (sensitivity 87.5% and specificity 86.5%). Among criteria for non-repairable MV, criteria 3 (severe thickening and/or calcification of leaflets) showed higher diagnostic performance than other two findings (AUC; 0.569 for criteria 1, vs. 0.540 for criteria 2 vs. 0.819 for criteria 3; P<0.05).

CONCLUSION

Cardiac CT may have high diagnostic performance in detecting the prolapsed segment of MV and predicting non-repairable MV before surgery. Among CT findings, valve morphology such as severe leaflet thickening and/or calcification is the most important predictor for non-repairable MV.

CLINICAL RELEVANCE/APPLICATION

Cardiac CT can be helpful to predict non-repairable MV before surgery, and valve morphology is the most important predictor.

SSJ03-05 Semi-Automatic CT-Angiography Based Evaluation of the Aortic Annulus in Patients Prior to TAVR: Interchangeability with Manual Measurements

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S502AB

Participants
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PURPOSE

To compare a semi-automatic software tool to full manual measurement to obtain aortic annulus parameters and determine trans-catheter aortic heart valve (THV) size in a large patient cohort prior to TAVR.

METHOD AND MATERIALS

We included 355 consecutive patients (156 male, median age 82 years) in this retrospective study. Two readers independently assessed aortic annulus size by manually determining long and short axis, circumference and area of the aortic valve annulus. A third independent reader performed annulus evaluation using a software tool for automatic detection and measurement of the aortic annulus plane (‚Valve Pilot', ‚CT Cardiac Function' tool, SyngoVia, Siemens Healthcare). Automatically detected annulus plane and contour could be manually changed if necessary. The parameter ‚annulus area' was used to determine optimal size of a hypothetical THV based on an algorithm suggested before (Binder et al. 2013). We calculated the intraclass calculation coefficient (ICC) to compare both manual measurements as well as semi-automatic measurements to the mean of both manual measurements.

RESULTS

There was excellent correlation between both observers in manual measurement of annulus long (ICC 0.89[95% CI 0.87;0.91]) and short axis (0.89[0.86;0.91]), circumference (0.93[0.92;0.95]) and area (0.94[0.93;0.96]). Both readers agreed in 81% (287/355) of patients regarding proposed THV size. During semi-automatic measurements, manual adjustment of the annulus plane and minimal adjustment of the annulus contour without changes in the automatically selected plane were performed in 11% (38/355) and 79% (282/355) of cases, respectively. No change of the suggested annulus segmentation was required in 10% of cases (35/355). Again, there was excellent correlation between semi-automatic measurements and mean of both manual measurements of long (0.89[0.87;0.91]) and short axis (0.86[0.83;0.88]), circumference (0.95[0.93;0.96]) and area (0.95[0.94;0.96]). Semi-automatic measurements resulted in identical THV size selection in 82% (290/355) of patients.

CONCLUSION

Semi-automatic measurements of anatomic parameters of the aortic root show high agreement with manual measurements in CT-angiography prior to TAVR.

CLINICAL RELEVANCE/APPLICATION

Semi-automatic assessment of the aortic root is equal to full manual measurement and can facilitate the complex evaluation of the aortic annulus prior to TAVR.

SSJ03-06 Prognostic Value of Left Ventricular Fibrosis Volume as a Parameter for Long-Term Survival after TAVI

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S502AB

Participants
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Jonathan Nadjiri, MD, Munich, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

Patients with severe aotic stenosis develop left ventricular hypertrophy. They suffer from reduced left venricular function. Due to the insufficient vascularization of the hypertrophic left ventricular myocardium the development of left ventricular fibrosis is a common problem in these patients. The transcatheter aortic valve implantation (TAVI) is an upcoming procedure to reduce the workload and improve the left ventricular funtion. The long-term-survival shows huge inter-individual differences. The assesment of NYHA class 30 days afer TAVI has shown to be a strong and independent parameter for long-term-survival. The aim of this study was to assess the value of left ventricular fibrosis volume as a predictive parameter for the clinical outcome after TAVI.

METHOD AND MATERIALS

In the study 35 consecutive patients with TAVI procedure were enrolled. The mean chracteristics were 81±7 years, mean NYHA class 3.2±1.4, EF 48±9.3%. In each patient pre-interventional contrast enhanced cardiac MRI was performed at a Philips Ingenia 3T. The left ventricular fibrosis volume was measured. The functional recovery was assessed using the NYHA class 30 days after the procedure.

RESULTS

NYHA class after TAVI was reduced significantly (1.7±1.3; $p<0.001$). Twenty-two (63%) patients revealed a 2 class reduction. Twelve (34%) patients showed a reduction of 1 class. One Patient remained in the same NYHA class. The left ventricular fibrosis volume was inversely related to the reduction of NYHA class: patients with left ventricular fibrosis volume of 720±232mm3 had a NYHA reduction of 2 or more classes whereas patients with a left ventricular fobrosis volume of 1501±321mm3 had a reduction of less than 2 classes.

CONCLUSION

The left ventricular fibrosis volume seems to have an impact on the reduction of the NYHA class 30 days after successful TAVI implantation.

CLINICAL RELEVANCE/APPLICATION

The quantification of the left ventricular fibrosis volume may be used as a prognostic parameter for long-term survival in TAVI patients.

SSJ04

Cardiac (Coronary Artery Disease: Outcomes and Risk Stratification)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S504AB

CA CT MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Udo Hoffmann, MD, Boston, MA (*Moderator*) Research Grant, HeartFlow, Inc

Sub-Events

SSJ04-01 Low Coronary Endothelial Shear Stress (ESS) Measured from Computed Tomography Angiography (CTA) is Associated with Early Fibroatheroma, and High ESS is Associated with High-Risk Thin Cap Fibroatheroma as Determined by Histologic Examination

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S504AB

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PURPOSE

ESS is associated with coronary plaque progression and modulates development of high-risk plaque features. However, the relationship between ESS and existing disease toward identifying the plaques at high risk of rupture has not been studied to date. We assessed whether ESS calculated from non-invasive coronary CTA can detect vulnerable plaque as determined by histopathologic examination.

METHOD AND MATERIALS

CTA was performed for 5 donor hearts with coronary artery disease. Histology was obtained every 1mm along the length of the major coronary arteries and coregistered to CTA using surgical knots and anatomic landmarks. Plaques were classified based on histology using the modified American Heart Association scheme: adaptive (AIT) and pathological (PIT) intimal thickening, fibrous (FIB), and, early (EFA), late (LFA) and thin-cap (TCFA) fibroatheroma. Resting-state ESS was calculated from CTA using a previously validated computational fluid dynamics (CFD) approach (non-Newtonian blood, flow proportional to myocardial mass and distributed using Murray's law). ESS was coregistered automatically to CTA, blinded to histology. Mean ESS at 0.5 mm intervals in each major artery was analyzed with one-way analysis of variance (ANOVA) to determine differences in ESS between plaque types. For plaque types associated with significantly different ESS, logistic regression and receiver operating characteristic analyses (ROC) were used to determine diagnostic accuracy of ESS to predict that plaque type.

RESULTS

214 histology sections with plaque were analyzed (31 AIT, 98 PIT, 37 FIB, 29 EFA, 9 LFA, 10 TCFA). Mean ESS differed significantly for TCFA vs all other types (p2.4 Pa to detect TCFA were 80%, 87.3%, and 86.9%, respectively. ESS detected EFA (ROC AUC=0.86, odds ratio=40.6/1Pa drop); sensitivity, specificity and diagnostic accuracy of ESS<1.1Pa to detect EFA were 86%, 75.9%, and 84.6%, respectively.

CONCLUSION

ESS from CTA detects EFA (low ESS2.4Pa). The former finding is in keeping with knowledge suggesting low ESS leads to early fibroatheromas. The latter finding implies a mechanical pathway (when high flow velocities and thus high ESS are present) in fibrous cap thinning and development of TCFAs.

CLINICAL RELEVANCE/APPLICATION

ESS from CTA detects thin-cap fibroatheroma and early fibroatheroma likely to progress to thin-cap. It can thus facilitate timely prevention or intervention, which no other non-invasive imaging offers.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying

educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Udo Hoffmann, MD - 2015 Honored Educator

SSJ04-02 Adjustment of CT-Fractional Flow Reserve Underestimation to Minimize 1-year Cardiac Events

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S504AB

Participants
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PURPOSE

CT-Fractional Flow Reserve (CT-FFR) is known to underestimate the FFR compared to invasive measurement, leading to considerable false-positive study results especially when the disease prevalence is low. The purpose of the study was to evaluate how an adjustment of CT-FFR's underestimation impacts the estimated clinical outcomes.

METHOD AND MATERIALS

This HIPAA-compliant, IRB-approved prospective study included 44 coronary arteries from 38 patients (67.8±9.6 yrs, ca score=347.7±459.3) who underwent a 1 heart-beat 320 row coronary CTA which showed 30-90% stenosis in at least one segment and also underwent invasive FFR. The CT-FFR was calculated onsite using a commercial software. We assessed the diagnostic accuracy of CT-FFR based on the receiver operating curve (ROC) using invasive FFR<=0.8 as a positive outcome. A hypothetical 1-year cardiac event incidence if revascularization (PCI) was decided based on CT-FFR was estimated, using previous evidences on incidences following invasive FFR (positive test (<=0.8) with PCI=0.03, without PCI=0.05, negative test (>0.8) with PCI=0.03, without PCI=0.01). We repeated the estimation with an adjustment of CT-FFR to minimize the deviation from invasive FFR, and assessed the change in the hypothetical cardiac events under four different disease prevalence (0.2, 1, 5, 10%).

RESULTS

A total of 16 vessels had significant ischemia (invasive FFR<=0.8). A cutoff CT-FFR of 0.8 achieved 94% sensitivity and 75% specificity (AUC of ROC=0.82), but it significantly underestimated the invasive FFR especially when CT-FFR was <0.7; estimated total cardiac events per 100,000 population was 158.7 under the 1% disease prevalence, 84.9 of which were events among patients with false-positive CT-FFR. After the adjustment of CT-FFR using a formula of 0.3X+0.634 for CT-FFR<0.7 to counteract its underestimation, the estimated total cardiac event decreased to N=123.5 at the 0.8 cutoff and was minimized to N=110 (30.5% reduction) at a 0.75 cutoff. When the disease prevalence was 0.2, 5, and 10%, the % reduction of the events was 31.5%, 25.4% and 19.5%.

CONCLUSION

Adjustment of CT-FFR to counteract the underestimation decreased the estimated 1-year cardiac events up to 31.5% depending on the disease prevalence.

CLINICAL RELEVANCE/APPLICATION

When using a CT-FFR to decide revascularization, underestimation should be adjusted to reduce cardiac events attributable to false positive results, especially when the disease prevalence is low

SSJ04-03 Sexual Dimorphism in the Association between Coronary Plaque Burden and Coronary Wall Thickness in Asymptomatic Coronary Artery Disease

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S504AB

Awards
Trainee Research Prize - Fellow

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PURPOSE

To evaluate the relationship between coronary plaque burden measured by Computerized Tomography Angiography (CTA) and coronary wall thickness (VWT) using Magnetic Resonance Imaging (MRI) in a low/intermediate risk asymptomatic population. The study also is to assess the value of VWT-MRI as a surrogate marker of plaque burden alone or in tandem with traditional atherosclerosis risk factors.

METHOD AND MATERIALS

We prospectively evaluated 124 asymptomatic adults with one or more modifiable cardiovascular risk factors. All subjects signed

informed consent for this IRB approved study and underwent CTA and 3 Tesla (3T) VWT-MRI. Estimated risk for atherosclerotic disease, coronary calcification, and plaque burden scores including segment involvement (SIS), volume (SVS) and stenosis scores (SSS) were obtained for all subjects. Series of univariable and multivariable generalized nonlinear regression modeling with consideration for interactions with gender were performed to investigate the association of traditional atherosclerotic risk factors and VWT with plaque burden scores.

RESULTS

A total of 62 male and 62 age- and BMI-matched female asymptomatic subjects with low/intermediate Framingham score (FrS) <20% were successfully imaged. Age, gender, and VWT, individually, were significant predictors of all coronary plaque burden scores. Additionally, gender remained a significant effect modifier in all plaque burden scores. In women, VWT, while in men, age, were the only common statistically significant predictor of coronary plaque burden scores with a statistically significant interactions between VWT and sex for SIS (ß=0.792, P =0.024) and for SSS (ß=1.292, P =0.009).

CONCLUSION

In asymptomatic subjects with low/intermediate FRS there is evidence of a sex-dimorphic association between VWT and gender as a predictor of coronary plaque burden. MRI-based VWT could supplement traditional risk scores for CAD risk stratification in women. This is in line with the previous studies that demonstrated the suboptimal performance of CAD risk score models for women compared to men.

CLINICAL RELEVANCE/APPLICATION

Coronary wall thickness measured noninvasively by MRI is a surrogate for subclinical atherosclerosis in low and intermediate CAD risk asymptomatic women but not in a similar male population. This sex-specific difference is clinically relevant for CAD risk stratification, life style modification and therapy of CAD in women.

SSJ04-04 Prevalence of Unrecognized Myocardial Infarction Detected By Cardiac Magnetic Resonance and Its Relation to Coronary Artery Calcium Score in Asymptomatic Asian Cohort

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S504AB

Participants
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PURPOSE

To investigate the prevalence of unrecognized myocardial infarctions (UMIs) in asymptomatic Asian subjects, assessed with cardiac magnetic resonance (CMR), and to relate the findings to cardiovascular risk prediction scores and coronary artery calcium (CAC) scores.

METHOD AND MATERIALS

Total 519 asymptomatic subjects (male:female, 476:43; age, 54.54 ± 6.41) who underwent both CMR and CAC scoring CT, with their interval less than 1 year, were included. Those with prior hospital-reported cardiovascular event were not included. Framingham risk score (FRS), ACC/AHA risk score and CAC score were assessed based on clinico-laboratory results and imaging data. Comparison of variables between those with and without UMI was performed by use of Student's t-test, Mann-Whitney test, chi-square test and Fisher's exact test. The confidence level and cutoff value of CAC score was analyzed with the receiver operating characteristic (ROC) method.

RESULTS

Late gadolinium enhancement (LGE) indicating UMI was noted in 12 of 519 subjects (2.3%). However, none of them showed pathologic Q-wave or ST-segment change on electrocardiography (ECG). Among clinico-laboratory results and risk prediction scores, only CAC scores differed significantly between those with and without UMIs ($p < .001$). The prevalence of UMI was as follows: 10 of 275 (3.6 %) in subjects with CAC score > 0 and 2 of 244 (0.8 %) in subjects with CAC score = 0. Among those with CAC score > 0, area under the ROC curve of CAC score for predicting UMI was 0.868 (95% CI, 0.823 - 0.906; $p < .001$). A CAC score with cutoff value of 301 demonstrated a sensitivity of 80.0% (95% CI, 44.4%-97.5%), a specificity of 86.0% (95% CI, 81.3%-90.0%), and a negative predictive value of 97.9% (95% CI, 95.0%-99.5%) in predicting UMI.

CONCLUSION

The prevalence of UMI in asymptomatic Asian subjects was 2.3%. CMR was a sensitive tool in depicting UMI and was superior to ECG. Those with CAC score above 301 can be potential candidates of CMR for UMI screening, as high CAC score is predictive of UMI.

CLINICAL RELEVANCE/APPLICATION

Asymptomatic individuals with CAC score above 301 are potential candidates of CMR for UMI screening, as high CAC score is predictive of UMI detected on CMR.

SSJ04-05 Correlation between Haptoglobin Phenotypes and Myocardial Reperfusion Injury in Consecutive ST-Elevation Myocardial Infarction as Detected by Cardiac Magnetic Resonance

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S504AB

Participants
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PURPOSE

Primary percutaneous coronary intervention (pPCI) has significantly reduced cardiovascular mortality of ST-segment elevation myocardial infarction (STEMI) patients. Cardiac magnetic resonance (CMR) has emerged as the gold standard technique for the measurement of the myocardial salvage index (MSI) and microvascular obstruction (MVO) over the traditional risk stratification. Aim of this study is to evaluate the correlation between variants of haptoglobin and myocardial reperfusion injury as detected by CMR in consecutive STEMI patients who underwent successful pPCI.

METHOD AND MATERIALS

Consecutive STEMI patients reperfused by primary PCI were enrolled. For each patient, the characterization of different phenotypes of haptoglobin was evaluated. Moreover, a CMR was performed by 1 week after STEMI evaluating: left ventricle ejection fraction (LVEF), MSI and prevalence and amount of MVO. The primary endpoint of study was to evaluate the correlation between different phenotypes of haptoglobin and myocardial reperfusion injury as detected by CMR.

CONCLUSION

Different variants of haptoglobin may play a crucial role in cardiac repair responses by reducing oxidative stress, maintaining microvascular integrity and proper scar formation. Further studies should be performed to evaluate if different therapeutic strategies should be developed based on phenotypes of haptoglobin of patients.

CLINICAL RELEVANCE/APPLICATION

haptoglobin may play a crucial role in cardiac repair responses and could represent a theraputic target in order to reduce myocardial reperfusion injury.

SSJ04-06 Coronary to Pulmonary Artery Fistula in the Adult: Natural History and Management Strategies

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S504AB

Participants
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PURPOSE

To evaluate the natural history of coronary-to-pulmonary artery fistula (CPAF) detected on coronary CT angiography (CCTA) and to propose potential treatment strategies.

METHOD AND MATERIALS

The institutional review board approved this retrospective study and informed consent was waived. 12,436 CCTA scans were performed in our institute between March 2009 and June 2016, and 74 patients were diagnosed as CPAF. Among them, patients with a follow-up of at least 2 years were retrospectively reviewed. Demographics, clinical history, prior cardiac testing, and reasons for CCTA were collected by a review of electronic medical records. The morphologic features of CPAF were analyzed, including vessel of origin site and number, size, and the presence of an aneurysmal sac. All patients were examined to what treatment they received after the diagnosis of CPAF. We investigated whether there were major adverse cardiac events (MACE), which was defined as the presence of death, myocardial infarction, and the need for revascularization or percutaneous intervention during the follow-up period.

RESULTS

48 patients had a follow-up period of more than 2 years. The mean age of the study population was 62 years (range 43-84, 39% male), and average follow-up period was 5.1 years. Common causes of CCTA were chest pain, palpitation, asymptomatic in order. Underlying diseases were hypertension, coronary artery disease, hyperlipidemia, and diabetes. The origin of CPAF was the left coronary artery in 22, the right coronary artery in one and both coronary arteries in 23 cases. More than half of the fistula sizes were less than 2 mm (26 cases, 62%). 12 cases were associated with an aneurysm (mean 12±7.5 mm). 4 cases underwent surgical ligation due to continued chest pain or having a larger aneurysm (range 12-19 mm). After the operation, they were free of a symptom. Another 44 patients were observed with optical medical treatments (OMT) and their symptom was controlled well. All

patients treated either surgery or OMT did not experience MACE during the follow-up period.

CONCLUSION

The natural course of CPAF detected by CCTA is usually benign. Optimal medical treatment is sufficient in most of the cases. Continued symptom and aneurysmal size are determinant for surgical ligation.

CLINICAL RELEVANCE/APPLICATION

As a treatment strategy for CPAF, OMT and observation are first and in most cases that are enough.

SSJ05

Science Session with Keynote: Chest (Lung Nodule/MRI)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404CD

CH MR OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants

Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Moderator*) Research Grant, Toshiba Medical Systems Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Fuji Pharma Co, Ltd; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Guerbet SA;
Andrew J. Plodkowski, MD, Syracuse, NY (*Moderator*) Nothing to Disclose
Jurgen Biederer, MD, Heidelberg, Germany (*Moderator*) Nothing to Disclose

Sub-Events

SSJ05-01 Chest Keynote Speaker: Focal Lung Lesions: The Potential Role of MRI for the Assessment of Malignancy

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S404CD

Participants
Jurgen Biederer, MD, Heidelberg, Germany (*Presenter*) Nothing to Disclose

ABSTRACT

In current practice, magnetic resonance imaging (MRI) of the lung is increasingly recognized as a valuable adjunct or even alternative to computed tomography (CT). Superior soft tissue contrast of morphologic sequences and the functional imaging capacities of MRI open new perspectives for detection and assessment of pulmonary malignancy. In a screening setting, applications range from lung MRI as the first choice screening modality to the role of an ad hoc on site test for the detailed evaluation of positive CT screening results with multi-parametric characterization of lung pathology. Malignant lung lesions, carcinoma, metastases, carcinoid and lymphoma usually show a nonspecific low or intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images. Short tau inversion recovery (STIR) sequences achieve a sensitivity of approximately 80 % and a specificity of 60%. Dynamic contrast enhanced (DCE) MRI is based on the evaluation of contrast uptake in the assessed lesion after bolus injection. It achieves specificities of 50-95% and sensitivities of 50-100% with diagnostic accuracies of 75-94%, hence coming close to the accuracies of contrast enhanced MDCT and FDG PET/CT. As in dynamic CT, it can be assumed that DCE MRI of solid pulmonary lesions has a high negative predictive value in cases of very low or missing enhancement after intravenous contrast application. More recently, diffusion weighted imaging (DWI) has been advocated for the assessment of focal lung lesions. DWI yields sensitivities between 70% and 90% and specificities of 60-95% for malignancy. However, DCE and DWI MRI cannot yet be considered robust, highly standardized and simple techniques for clinical use. The applied protocols vary widely and solutions for basic problems such as compensation for respiratory motion and for the non-linearity of blood/tissue-signal with gadolinium-concentration are still subject to research. Further methods to evaluate tumor viability based on multi-parametric MRI are on an early, experimental level. The presentations comprised within this scientific session will contribute valuable insights into the further development, application, performance and diagnostic yield of these emerging techniques.

SSJ05-02 Diagnostic Performance of Diffusion-Weighted Imaging with Multiple Parameters for Assessment and Characterization of Pulmonary Lesions: A Meta-Analysis

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S404CD

Participants
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PURPOSE

Regarding DWI application in thoracic disease, several appropriate parameters have been reported, commonly including 5-point rank scale, lesion-to-spinal cord ratio (LSR) and apparent diffusion coefficient (ADC). This study aimed to evaluate the diagnostic performance of diffusion-weighted imaging (DWI) using these three parameters for the characterization of pulmonary lesions.

METHOD AND MATERIALS

After literature search in several databases (the PubMed, EMBASE, Cochrane library and China National Knowledge Infrastructure databases), two investigators independently selected studies, assessed methodological quality, and extracted data. On a per-lesion basis, we pooled and compared three parameters between malignant and benign pulmonary lesions. Then, we determined pooled sensitivity and specificity with individual 95% confidence intervals (CIs). In addition, the summary receiver operation characteristic curves (SROC) for DWI with area under the curve (AUC) and Q* index were constructed.

RESULTS

In total, 31 articles involving 2368 lesions were included. The score of 5-point scale of malignant and benign lesions were 3.83

(3.71-3.96) and 2.36 (2.18-2.54), respectively. The LSR of malignant and benign lesions were 1.15 (1.07-1.24) and 0.71 (0.62-0.79), respectively. The ADC values of malignant lesions and benign lesions were 1.23 (1.21-1.24) and 1.72 (1.68-1.77), respectively. All of three parameters differed significantly between malignant and benign lesions (Figure 1) ($p<0.05$). With a cut-off value of 3, the pooled sensitivity and specificity were 0.88 (0.84-0.91) and 0.75 (0.68-0.80) for 5-point scale. The SROC curve displayed AUC of 0.9107 and Q* index of 0.8429, respectively. For LSR, the pooled sensitivity, specificity, AUC and Q* index were 0.80 (0.75-0.85), 0.85 (0.76-0.92), 0.9159 and 0.8487, respectively. The ADC measurements yielded the pooled sensitivity of 0.84 (0.82-0.86), pooled specificity of 0.84 (0.81-0.87), AUC of 0.9198, and Q* index of 0.8532.

CONCLUSION

DWI can help to distinguish malignant from benign pulmonary lesions based on visual parameter (5-point scale), semiquantitative parameter (LSR) and quantitative parameter (ADC).

CLINICAL RELEVANCE/APPLICATION

In clinical practice, 5-point scale, LSR, and ADC were useful diagnostic parameters for pulmonary lesions, and the diagnostic performances of them did not show any significant differences.

SSJ05-03 Assessment of Intravoxel Incoherent Motion Diffusion-Weighted MR Imaging in Solitary Pulmonary Nodules: Comparison and Correlation with Dynamic Contrast-Enhanced MR Imaging

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S404CD

Participants
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PURPOSE

To compare intravoxel incoherent motion (IVIM) and dynamic contrast-enhanced MR imaging (DCE-MRI) in their ability to discriminate lung cancer(LC) from benign pulmonary lesions.

METHOD AND MATERIALS

57 consecutive patients with solitary pulmonary nodules underwent DW-IVIM (multi-b-factor DWI with b values of 0, 20,50, 100, 150,200, 400, 600, and 1000 s/mm2) and DCE-3.0T MRI. ADCtotal, Tissue diffusivity (D), pseudo-diffusion coefficient (D*), and perfusion fraction (F) were calculated with mono--exponential and IVIM models. MER,Tmax, SLE and washout were calculated with semi-quantitative DCE analysis. Receiver operating characteristic (ROC) curves was constructed to estimate the diagnostic performance of both methods in differentiating diagnosis and the optimal cut-off values were obtained.

RESULTS

ADCtotal and D were significantly higher for benign lesions than for LC ([1.83?±?0.66]?×?10-3 mm2/s vs. [1.30?±?0.40]?×?10-3 mm2/s; P?=?0.005; [1.33?±?0.43]?×?10-3 mm2/s vs. [0.88?±?0.29]?×?10-3 mm2/s; P?=?0.002). D*was found to be significantly higher in LC than benignity ([50.65?±?46.08] ×?10-3 mm2/s vs. [19.68?±?30.54] ×?10-3 mm2/s; P?=?0.005). No difference was observed in F between LC and benignity (P?=?0.06).By DCE-MRI,Tmax were significantly shorter in LC than that of benignity([131.6?±?83.4]?s vs. [309.7?±?126.0]?s; P? **CONCLUSION**

Both IVIM model based on DWI and DCE-MRI were useful for discriminating benign lesions from malignant pulmonary nodules, and can provide quantitative diffusion and perfusion information by multiple parameters. We suggest that a combined DCE and IVIM could provide a more promising way in determination microstructure characteristics of solitary pulmonary nodules.

CLINICAL RELEVANCE/APPLICATION

Combination of DCE and IVIM could provide an alternative noninvasive method for diagnosis of SPN without radiation explosure.

SSJ05-04 How to Apply Computed Diffusion-Weighted Image for Improving Diagnostic Performance of Chest MR Imaging in Patients with Pulmonary Nodules?

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S404CD

Participants
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PURPOSE

To determine the utility of computed diffusion-weighted image (cDWI) for improving diagnostic performance on chest MR imaging in patients with pulmonary nodules.

METHOD AND MATERIALS

61 consecutive patients (38 men and 23 women; mean age, 69.1±9.7 years) with 82 pulmonary nodules underwent DWIs,

transbronchial or CT-guided biopsies, surgical resection, pathological, microbaclterial and follow-up examinations. All DWI were obtained at a 3T MR system by using fast advanced spin-echo (FASE) sequence with b values at 0 and 1000s/mm2. As well as actual DWI at 1000s/mm2 (aDWI), cDWIs were generated at b value as 400 (cDWI400), 600 (cDWI600), 800 (cDWI800), 1000 (cDWI1000), 1500 (cDWI1500) and 2000 (cDWI2000) s/mm2 by commercially available software. According to results of pathological and follow-up examinations, all nodules were divided into malignant (n=41) and benign (n=41) nodule groups. Then, signal-to-noise ratio (SNR) and contrast ratio (CR) between nodule and thoracic muscles were determined by ROI measurement at each nodule. To compare image quality between aDWI and each cDWI, SNRs were compared by Dunnett multiple comparison test. To determine the utility of cDWI with aDWI, the logistic regression analysis was also performed with aDWI and all cDWIs. To compare diagnostic performance of pulmonary nodule, ROC analyses were performed among aDWI, each DWI and combined aDWI with appropreate cDWI determined by logistic regression analysis. Finally, sensitivity, specificity and accuracy were compared by McNemar's test.

RESULTS

SNRs of cDWI400 (p=0.002) and cDWI600 (p=0.008) were significantly higher than that of aDWI1000, although that of cDWI1500 (p<0.001) and cDWI2000 (p<0.001) were significantly lower than that of aDWI1000. Logistic regression analysis showed aDWI and cDWI600 were significant predictors for diagnosis of malignancy (p<0.05). Accuracy of aDWI with cDWI600 (86.6 [71/82] %) was significantly higher than that of aDWI (81.7 [67/82] %, p<0.05).

CONCLUSION

Computed DWI has a potential to improve diagnostic performance of DWI in patients with pulmonary nodules, when generated at appropriate b value.

CLINICAL RELEVANCE/APPLICATION

Computed DWI has a potential to improve diagnostic performance of DWI in patients with pulmonary nodules, when generated at appropriate b value.

SSJ05-05 The Value of Differential Diagnosis the Invasive Adenocarcinoma of Lung in 3T MRI

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S404CD

Participants
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PURPOSE

To investigate the value of magnetic resonance imaging (MRI) in differential diagnosis of invasive pulmonary adenocarcinoma (IPA) appearing as ground-glass nodules

METHOD AND MATERIALS

Retrospective analysis was performed on CT and MRI findings in patients with pulmonary ground-glass nodules from December 2014 to December 2016. All patients were undergo the surgery and pathologically proved, they were pre-cancerous lesions or clinical stage 1 of lung adenocarcinoma. The image features of the lesions were analyzed by two readers who did not know the pathological results. Maximum diameter, T2 signal intensity and ADC value were measured. According to the pathology, the lesions were divided into two groups. One included pre-invasive lesion (AAHs and AISs) and MIAs, another included IPAs. Compared the 3 indicators between two groups . All statistical analyses were performed using SPSS 21.0. The measurement data were analyzed by using two independent samples t test,If it was suitable for the normal distribution, otherwise using Mann-Whitney U test. Count data were compared using chi square test. Receiver operating characteristic (ROC) curve analysis were performed to evaluate diagnostic test.

RESULTS

A total of 34 participants (14 male, 57.1±14.7 year-old; 20 female, 54.9±10.1year-old) with 34 nodules were enrolled in the study. There were 15 cases in group A , including 4 AAH, 2 AIS and 9 MIA, and19 cases in group B. There was no significant differences in the age of patient and gender between the two groups. The maximum diameter of lesions in group A was significantly less than that in group B(9.9±2.6mm vs 13.1±2.7mm). The T2 signal intensity of lesions in group A was significantly lower than that in group B(93.0±8.3 vs 113.6±22.9).The ADC value in group A(1.0±0.2*10-3 mm2/s) was also significantly lower than that in group B (1.3±0.3*10-3 mm2/s). The best index to distinguish the two groups is the maximum diameter of lesions The optimal cut-off value for maximum diameter was 11.5mm (sensitivity, 73.7%; specificity, 73.3%).The AUC for maximum diameter was 0.791 (95% confidence interval: 0.640,0.942)

CONCLUSION

The maximum diameter of the nodule, T2 signal intensity and ADC value are helpful for differential diagnosis of invasive lung adenocarcinoma.

CLINICAL RELEVANCE/APPLICATION

The maximum diameter of the nodule, T2 signal intensity and ADC value are helpful for differential diagnosis of invasive lung adenocarcinoma.

SSJ05-06 Primary Tumor Cellularity Assessed on Diffusion Weighted MRI and Metabolism Assessed on PET/CT as Predictive Factors for Lymph Node Involvement in Non-Small Cell Lung Cancer (NSCLC)

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S404CD

Participants
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PURPOSE

The aim of this study was to prospectively analyze the potential role of primary tumor apparent diffusion coefficient (ADC) derived from whole body MRI (WB-MRI) with diffusion weighted imaging (DWI) and metabolic parameters derived from FDG PET/CT in predicting pathologically assessed lymph node metastasis in non-small cell lung cancer (NSCLC) patients before treatment.

METHOD AND MATERIALS

Ethic committee approval was obtained for this prospective study as well as written informed consent from every patient. The study group comprised 32 consecutive patients (mean age: 67yrs) with histologically proven NSCLC (SCC n= 8 and AC n=24) who underwent 1.5 T WB-MRI with DWI and FDG PET/CT before treatment. Maximum diameter (maxTD) and minimum and mean ADC (ADCmin and ADCmean) of primary tumor were calculated on DWI images (b-values 0-1000). Maximum standardized uptake value (SUVmax), metabolic tumor volume (MTV) and total lesion glycolysis (TLG) were measured on FDG PET/CT. Presence of lymph node (LN) metastases was pathologically assessed and served as reference standard. Relationships between imaging metrics and LN status were evaluated using the Mann-Whitney U test. The area under the receiver operating characteristic (ROC) curve was used to evaluate accuracy.

RESULTS

Lymph node metastasis were documented in 11 patients (34%). There were significant correlations between primary tumor maxTD, ADCmean, MTV, TLG and presence of LN metastasis (p: 0.05, 0.05, 0.04 and 0.04 respectively). ADCmin and SUVmax were not associated with LN metastasis. On ROC curve analysis, the areas under the curve (AUC) for maxTD, ADCmean, MTV and TLG for were 0.71, 0.70, 0.71 and 0.73 respectively, for predicting LN status.

CONCLUSION

Parameters derived from pre-treatment WB-MRI with DWI (maxTD and ADCmean) and from FDG PET/CT (MTV and TLG) may serve as predictive biomarkers of lymph node metastasis in patients with non small cell lung cancer.

CLINICAL RELEVANCE/APPLICATION

Diffusion weighted MRI and FDG PET/CT functional characteristics of the primary tumor can be used for predicting pathologic lymph-node involvement in NSCLC patients.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSJ06

Emergency Radiology (Neuroradiology)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N227B

CT ER NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Clint W. Sliker, MD, Ellicott City, MD (*Moderator*) Nothing to Disclose
Jamlik-Omari Johnson, MD, Atlanta, GA (*Moderator*) Research Grant, Koninklijke Philips NV; Royalties, Cambridge University Press

Sub-Events

SSJ06-01 Evaluation of CT Time Efficiency in Acute Stroke Response

Tuesday, Nov. 28 3:00PM - 3:10PM Room: N227B

Participants
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PURPOSE

Time-efficient CT imaging in acute stroke is essential for improving patient outcomes. This can be systematically evaluated using imaging timestamps. In this work, we retrospectively analyzed CT imaging speed in acute stroke response and compared performance between different scanners, times of day, and technologists.

METHOD AND MATERIALS

We extracted timestamps related to image acquisition, reconstruction, and availability in PACS from 636 complete acute stroke CT exams at a single institution under IRB approval. Exams were sorted by technologist, scanner location, and time of day. To investigate differences in efficiency by scanner location and exam time, we used Mann-Whitney U tests to compare the time of acquisition and time to PACS for each of the four series in our stroke CT protocol (head without contrast, CTA, perfusion, head with contrast). Non-parametric tests were used to investigate differences in efficiency by scan operator, including a Kruskal-Wallis test and *post hoc* Mann-Whitney U tests.

RESULTS

A significant increase in time from exam start to image availability for interpretation was observed in all series from exams performed on the Emergency Department (ED) back-up scanner in Radiology compared to those performed on the dedicated CT in the ED (p<0.001, median 3-4 min depending on series). This was despite there being no significant difference in image acquisition time. Despite increased acquisition time during overnight shifts, CTA, perfusion, and head with contrast series were available in PACS significantly sooner during the night shift (p<0.01, median 2-3 min). Comparisons between CT technologists indicated significant differences between operators in exam acquisition time and time to image availability in PACS (p<0.05, median time differed by up to 5.5 and 14 min, respectively).

CONCLUSION

There were significant differences in the speed of image acquisition, processing, and availability for interpretation based on scanner location, time of day, and operator. These findings can direct our efforts for improved training and more rapid acute stroke care. This method of quality analysis will be useful for continued monitoring of performance in the future.

CLINICAL RELEVANCE/APPLICATION

This study demonstrates a method for performance monitoring in stroke care using imaging timestamps. The results indicate new areas for quality improvement in our institution's acute stroke workflow.

SSJ06-02 Dual Energy CT Angiogram of the Head: Quantifying Iodine Concentration in Acute Ischemic Stroke

Tuesday, Nov. 28 3:10PM - 3:20PM Room: N227B

Participants
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Axel C. Rohr, MD, Kiel, Germany (*Abstract Co-Author*) Nothing to Disclose
Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG

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PURPOSE

Non-contrast CT and CTA provides a rapid, accessible and accurate assessment of parenchymal infarction in acute ischemic stroke (AIS). CTA has also been shown to demonstrate areas of low cerebral blood volume in regions of infarction.The advent of dual energy/spectral imaging presents the potential to quantify iodine in the region of infarct. Our study aims to assess whether iodine quantification can reliably differentiate between infarcted and normal brain in patients presenting with AIS.

METHOD AND MATERIALS

A retrospective study on patients that presented to the Emergency Department (ED) at our institution between January and April, 2016, with clinical suspicion of acute MCA territory infarction within the last 4 hours and underwent contrast enhanced DECT angiogram of the head and neck (N = 34). Catheter angiography served as the reference standard.Images were acquired on a third generation dual-source, DECT scanner at 90 kV and Sn150 kV. Iodine Overlay (IO) images were reconstructed and iodine measurements were normalized to that of the precentral gyrus on the unaffected side. ROIs were drawn over the insular cortex , basal ganglia (BG) and white matter (WM) external capsule in the region of the ischemia and contralateral normal parenchyma to measure iodine concentration and calculate percentage uptake. Mean values were compared between normal and ischemic parenchyma.

RESULTS

The mean iodine concentration and percent iodine values for the normal and ischemic brain tissues were as follows: 1.01 ± 0.04 mg/ml and 92.69% ± 2.2 for normal insula and 0.26 mg/ml ± 0.03 and 23.41% ± 2.2 for ischemic insula; 0.35 mg/ml ± 0.03 and 29.75% ± 2.2 for normal WM and 0.13 mg/ml ± 0.02 and 10.48% ± 1.4 for ischemic WM; and 0.7 mg/ml ± 0.05 and 65.12% ± 3.7 for normal BG and 0.28 mg/ml ± 0.04 and 24.68% ± 3.5 for ischemic BG. Infarcted brain GM, WM, and BG exhibited statistically significant less iodine concentration compared to their normal counterparts ($p < 0.0001$).

CONCLUSION

Iodine quantification in DECT reliably differentiated between normal and infarcted brain tissue in our study. Its use in the acute stroke imaging protocol improved detection of acute infarcts on DECTA images of the head.

CLINICAL RELEVANCE/APPLICATION

Iodine quantification in DECTA images may improve detection of acute infarcts in patients presenting with acute stroke symptoms.

SSJ06-03 Impact of Reader Experience and Greyscale Inversion on the Detection of Emergent Large Vessel Occlusion Stroke with CT Angiography

Tuesday, Nov. 28 3:20PM - 3:30PM Room: N227B

Participants
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PURPOSE

CT angiography (CTA) is now an essential component of acute stroke imaging protocols to confirm or exclude the presence of emergent large vessel occlusion (ELVO) stroke. ELVO detection must be possible at all levels of training and without sub-specialized training. This study examines sensitivity, specificity, agreement, reading time, time to detection, and self-reported confidence for ELVO detection between neuroradiologists, non-neuroradiologists, and residents using both greyscale inversion (black blood) and normal viewing conditions.

METHOD AND MATERIALS

A random and counterbalanced experimental design was used, where 16 radiologists (10 attendings, 6 residents) read the same patient images with and without greyscale inversion, counterbalanced by a one month separation, while being blinded to patient information (radiologist and patient were held constant). Positive and negative ELVO cases (n=52) were randomly ordered using a balanced design (26 vs. 26) to optimize detection of changes in sensitivity and specificity; PPV/NPV were used for group comparisons, not estimation. Diagnostic performance, including sensitivity, specificity, PPV, NPV, as well as confidence, and read and detection time were examined between by experience and greyscale inversion (on/off) using generalized mixed modeling assuming a binary, negative binomial, and binomial distributions, respectively, where observations were nested within radiologist

within patient (SAS/GLIMMIX).

RESULTS

No differences were detected between greyscale inversion on/off and between groups concerning diagnostic performance (p=0.34), detection time (p=.15), overall read time (p=.97), and confidence (p=.06). Differences were observed between level of training: residents were less confident than attendings, and neurorads were faster than non-neuro rads and residents concerning read time, all p<.01). Lack of differences between on/off are not surprising, given that sensitivity, specificity, PPV, NPV where very high to begin with little room for improvement (ceiling effect).

CONCLUSION

ELVO detection with CT angiography is accurate across all levels of training and experience. Greyscale inversion offered no significant detection advantage.

CLINICAL RELEVANCE/APPLICATION

These results show that diagnostic performance and time to detection are very good, regardless of training and specialty, for an examination that must be a part of the initial hospital evaluation of stroke patients.

SSJ06-04 The Utility of Virtual Non-Contrast Images in Assessment of Acute Intracranial Pathology

Tuesday, Nov. 28 3:30PM - 3:40PM Room: N227B

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PURPOSE

The purpose of this study is to evaluate whether virtual non-contrast (VNC) images derived from DE CT angiography (CTA) are as reliable as true non-contrast CT (NCCT) images in detecting brain hemorrhage and infarcts.

METHOD AND MATERIALS

A total of 56 patients with acute stroke symptoms were retrospectively identified between January and April 2016 from a single institution's emergency department. All the patients underwent both an NCCT and DE CTA. DE images were acquired at 90 kV and Sn 150 kV. Quantitative analysis of the NCCT and VNC Head images were performed using circular region of interests (ROIs) centered on the basal ganglia, internal capsule and the superior sagittal sinus. Mean Hounsfield Units (HU) ± noise was calculated. Two radiologists were blinded and retrospectively interpreted the VNC CT images in comparison to the routine NCCT, assessing for pathology and diagnostic acceptability. The studies were graded on a 5 point Likert scale with 1 being a non-diagnostic examination and 5 representing a diagnostic study similar to a TNC scan. Sensitivity and specificity of VNC at detecting hyperdense-vessel sign, hemorrhage and infarction.

RESULTS

There was no significant difference between attenuation values for the basal ganglia, internal capsule and superior sagittal sinus on TNC (38.6 HU ± 0.57, 30.3 HU ± 0.56 and 56.5 HU ± 1.4) and VNC (35.6 HU ± 1.6, 30.5 HU ± 1 and 56.2 HU ± 5.2) (p > 0.1).Sensitivity and specificity of VNC for detection of hemorrhage, hyperdense-vessel sign and infarct was 100% and 100%, 80% and 77.4% and 38.2% and 100% respectively.

CONCLUSION

VNC images were as reliable as TNC images for detecting hemorrhage and demosntrated acceptable performance in detecting hyperdense-vessel sign. However, VNC images did not reliably detect infarct as compared to TNC images.

CLINICAL RELEVANCE/APPLICATION

VNC images can reliably diagnose intracranial hemorrhage, however, are not as of yet reliable to forgo the inclusion of a TNC scan in cases of suspected infarction.

SSJ06-06 Temporal Changes and Spectrum of Findings on Follow-up CT Angiogram in Patients with Suspected Post-traumatic Blunt Cerebrovascular Injury

Tuesday, Nov. 28 3:50PM - 4:00PM Room: N227B

Participants
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PURPOSE

Blunt cerebrovascular injury (BCVI) is a rare but potentially devastating diagnosis. If left undiagnosed and untreated, the incidence of ischemic stroke is reported to be as high as 64%. Follow-up imaging is recommended in suspected or confirmed cases of BCVI within 24-48 hours. Our study establishes the temporal changes and findings on follow-up imaging.

METHOD AND MATERIALS

For this retrospective, IRB-approved study, the hospital trauma registry was queried for all poly-trauma patients undergoing CTA scans performed in the emergency department between January 1, 2010 to December 31, 2016 with ISS >= 16, yielding 3747 patients. A total of 205 patients had follow up CTs for BCVI. Note was made of the grade and location of injury as well as associated traumatic injuries. GCS at the time of admission was also recorded.

RESULTS

Vehicular collision was the most common mechanism of injury (66%). The majority of patients (62%) had a GCS of 10-15. 18 cases (9%) had GCS of 3-9 and 53 patients (26%) were unresponsive at the time of presentation. 6 patients were intubated at the scene. Vertebral fractures were the most common associated injuries (54%), Intracranial hemorrhage in 42%, skull fractures in 26% and facial fractures in 29% of patients. 16% of patients had no associated injuries.The overall incidence of BCVI in our study was 4.8%. 59% of injuries involved the vertebral arteries (101) and 41% involved the internal carotid arteries (71). On the initial CTA 48% of injuries were Grade I, 27% were Grade II, 6% were Grade III, 18% were Grade IV and 1% were Grade V. On follow-up CTA, Grade I injuries made up 43% of cases, 18% were Grade II, 18% were Grade III, 20% were Grade IV and there were no Grade V injuries on follow up. 45% of all BCVI remained unchanged on follow-up imaging, 42% improved and 13% worsened on follow-up imaging.All patients with diagnosis or suspicion of BCVI received medical therapy within 24 hours of diagnosis. 6 patients underwent image guided vascular intervention.

CONCLUSION

Aggressive screening for BCVI in trauma enables early diagnosis and management of injuries. Low grade injuries are more likely to demonstrate changes on follow-up imaging. The majority of cases demonstrated improvement compared baseline.

CLINICAL RELEVANCE/APPLICATION

It is important to recognize that BCVI may improve or worsen on follow up imaging, which may affect management and patient outcomes.

SSJ07

Gastrointestinal (Radiomics)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

CT GI MR PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Kathryn J. Fowler, MD, Saint Louis, MO (*Moderator*) Nothing to Disclose

Sub-Events

SSJ07-01 Radiomics-Based Quantification and Classification of the Phenotype of Pancreas Cystic Neoplasms on Abdominal CT Images

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E350

Participants
Seyoun Park, Baltimore, MD (*Presenter*) Nothing to Disclose
Linda C. Chu, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Pancreatic cystic masses are detected in greater than 2% of abdominal CTs, and they vary in malignant potential based on underlying pathologic diagnosis. Many of these cystic masses share overlapping imaging features and are difficult to confidently diagnose based on visual assessment of these imaging features. The purposes of this study are to quantify the phenotype pancreas cystic neoplasms and to use these radiomics features to classify different types of pancreatic cystic masses.

METHOD AND MATERIALS

This was an IRB-approved retrospective study. 103 patients with pathologically proven pancreatic cystic masses with preoperative dual-phase pancreatic protocol CT were identified from the radiology and pathology database from 2003 to 201 6. This included 60 intraductal papillary mucinous neoplasm (IPMN), 8 mucinous cystic neoplasm, 20 serous cystadenoma, 10 solid pseudopapillary epithelial neoplasm, and 5 pancreatic neuroendocrine tumor. Primary cystic masses and whole pancreas were manually segmented using dedicated software, the Medical Imaging Interaction Toolkit (MITK) . The phenotype of each cyst was expressed by 478 radiomics features, including the first order statistics, shape, texture, and textures from wavelet and Laplacian of Gaussian. Additional 10 statistics from the whole pancreas and 2 demographic features of age and gender were also used for the analysis of the types of cyst. The minimum redundancy maximum relevance feature selection was applied for feature dimension reduction.

RESULTS

Among the whole 490 features, thirty features were found for the binary classification of IPMN. The matching results to clinical outcomes show 0.883 of sensitivity and 0.721 of specificity with 81.6% of overall accuracy (AOC area: 0.873). For all five types, thirty-five features were extracted with 72.8% of correctly classified cases by 10-fold cross validation. Age, median and mean intensities of wavelets, and fractal dimension were highly ranked for the both classifications.

CONCLUSION

Radiomics features were significantly different among different types of pancreatic cystic neoplasms and were helpful for the classification of pancreatic cystic neoplasms.

CLINICAL RELEVANCE/APPLICATION

Radiomics features can be used for the classification of pancreatic cystic neoplasms.

SSJ07-02 Radiomics Approach to Characterize Microsatellite Instability (MSI): A CT-Based Radiomic Signature for the Detection of the MSI-H Phenotype in Colorectal Cancer

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E350

Participants
Yanqi Huang, Guangzhou, China (*Presenter*) Nothing to Disclose
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PURPOSE

To develop and validate a CT-based radiomic signature for the preoperative detection of the MSI-H (high levels of microsatellite instability) phenotype in patients with colorectal cancer.

METHOD AND MATERIALS

Ethical approval by the institutional review board was obtained for this retrospective analysis, and the informed consent was waived. The primary cohort of this study consisted of 140 patients with clinicopathologically confirmed CRC, with data gathered from January to December 2011; while the independent validation cohort consisting of 114 consecutive patients collected from January to December 2012. 591 radiomic features were extracted from preoperative portal venous-phase computed tomography (CT) of CRC. Lasso regression model was used for data dimension reduction, feature selection, and radiomics signature building. The discrimination and calibration performance of the developed radiomics signature was assessed in primary cohort and then validated in the independent validation cohort.

RESULTS

After feature redcution and selection, 29 radiomics features were used to develop the radiomic signature. In both the primary and validation cohort, the radiomic signature was significantly associated with the MSI-H phenotype (P<0.001 for primary cohort; P=0.012 for validation cohort). The radiomic signature showed good discrimination, with a C-index of 0.914 (95%CI: 0.901, 0.927) in primary cohort and 0.702 (95%CI: 0.677, 0.727) in validation cohort. Good calibration of the radiomic signature was depicted in calibration curves in both the primary and validation cohort.

CONCLUSION

This study presents a CT-based radiomic signature that can be conveniently used to facilitate the preoperative individualized detection of MSI-H phenotype in CRC patients, which could be useful for informing patient prognosis and guiding the personalized therapy of CRC including adjuvant chemotherapy, targeted therapy, and immune checkpoint inhibitor therapy.

CLINICAL RELEVANCE/APPLICATION

The developed and validated CT-based radiomic signature could facilitate the preoperative individualized detection of MSI-H phenotype CRC, which further advances the role of MSI in informing patient prognosis and guiding the personalized therapy of CRC including adjuvant chemotherapy, targeted therapy, and immune checkpoint inhibitor therapy.

SSJ07-03 Comparison between Radiomics Analysis and Subjective Visual Assessment of T2-weighted MRI Images for the Identification Of >=T3 Rectal Cancer

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E350

Participants
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PURPOSE

To determine if radiomics outperforms visual assessment based on T2-weighted imaging (T2-W) for the discrimination between <=T2 and >=T3 rectal cancer

METHOD AND MATERIALS

The study included all patients with rectal cancer who underwent total mesorectal excision as primary curative treatment, without neoadjuvant therapy, at our institution, between October 2013 and December 2016 (n=26, 14 males, mean age=67 years). Two patient groups were formed based on pathological stage, <=T2 (n=13) and >=T3 (n=13). All patients underwent staging MRI before surgery comprising T2-W imaging in axial, coronal and sagittal planes. T2-W images were blindly reviewed in consensus by 2 radiologists and primary tumors were classified as >=T3 or <=T2. A volume of interest (VOI) was drawn in consensus by the 2 radiologists, based on axial T2-W images, encompassing the whole primary tumor and corresponding datasets were analyzed using the PyRadiomics package. Wilcoxon-Mann-Whitney test was used to define the discriminating power between the 2 groups, of each of the 1831 features separately. Feature reduction was done using a cut-off correlation coefficient of 0.99 to remove redundant features. Multiple comparisons correction was done based on an FDR test. The best performing feature was selected, and its diagnostic accuracy was compared to that of visual radiological assessment using DeLong's test

RESULTS

23 radiomics features provided with statistically significant differences (p<0.05) between the 2 groups, while the best performing feature was the Low Gray Level Run Emphasis - GLRLM of the exponential of the original image with sensitivity, specificity and area under the ROC curve (AUROC) of 0.79, 0.92 and 0.92, respectively. Sensitivity, specificity and AUROC were 0.93, 0.67 and 0.80, respectively, for visual radiological evaluation. The performance difference between visual assessment and radiomics analysis was not statistically significant (p=0.21)

CONCLUSION

Our preliminary results indicate that radiomics analysis doesn't provide higher performance compared to visual radiological assessment for the identification of >=T3 rectal cancer based on T2-W images.

CLINICAL RELEVANCE/APPLICATION

Radiomics analysis and difficult issues in rectal cancer staging: applicability in the identification of >=T3 rectal cancer

SSJ07-04 Predicting Early Recurrence of Hepatocellular Carcinoma with Texture Analysis of Pre-Operative Magnetic Resonance Imaging: A Radiomics Study

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E350

Awards
Student Travel Stipend Award

Participants
Terrence C. Hui, MBBS,MRCS, Singapore, Singapore (*Presenter*) Nothing to Disclose
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PURPOSE

To study the feasibility of using texture analysis in pre-operative magnetic resonance imaging (MRI) to predict early recurrence (ER) in hepatocellular carcinoma (HCC) post-curative surgery.

METHOD AND MATERIALS

Institutional review board was obtained. A retrospective review of all patients who underwent hepatectomy between 1 Jan 2007 and 31 Dec 2015 was performed. Inclusion criteria: pre-operative MRI, tumor size >=1cm, new cases of HCC. Exclusion criteria: Loss-to-follow-up, ruptured HCCs, movement artifacts and previous hepatectomy or interval adjuvant therapy. Patients were divided into ER and late or no recurrence (LNR) groups. Early recurrence was defined as new foci of HCC within 730 days of curative surgery. Plain, diffusion-weighted, arterial and portovenous acquisitions were imported into MATLAB (Mathworks, Matick, MA, USA). Radiomics feature extraction was performed on the largest cross-sectional area of each tumor. MaZda software (version 4.6.2.0) was used to analyze 290 texture parameters and PRTools was used for feature selection.

RESULTS

Fifty-seven patients (49 male, mean age 66.5 years) were divided into ER (n=21) and LNR (n=36) groups. Differences in alpha-fetoprotein level (p=0.021), tumor size (p=0.011), restricted diffusion (p=0.01) and vascular invasion (gross and/or microvascular, p=0.047) between the 2 groups were found to be statistically significant. Texture analysis revealed 79% accuracy in classifying arterial images using 1-nearest neighbor using parameters S(1,0)Contrast or S(5,-5)Entropy. The parameter S(5,-5)Entropy has also resulted in 77% accuracy in classifying T2 images.

CONCLUSION

Early recurrence of HCC can be predicted on pre-operative MRI with 79% accuracy using the appropriate texture analysis parameter.

CLINICAL RELEVANCE/APPLICATION

Post-operative recurrence of HCC results in mortality and the time-to-recurrence duration is an independent prognostic factor of survival. The ability to identify these high-risk patients pre-operatively will potentially guide both surgical management, such as resecting a wider margin or liver transplantation, as well as post-operative surveillance and therapeutic interventions.

SSJ07-05 Quantification of Hepatocellular Carcinoma Heterogeneity with Multiparametric Magnetic Resonance Imaging

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E350

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

To quantify heterogeneity in hepatocellular carcinoma (HCC) using multiparametric (mp) magnetic resonance imaging (MRI), and to

report preliminary data correlating quantitative MRI parameters with histopathology and gene expression in a subset of patients.

METHOD AND MATERIALS

Thirty-two HCC patients (M/F 26/6, mean age 59 years) with 39 HCC lesions were included in this prospective study. The mpMRI protocol consisted of diffusion-weighted imaging (DWI), blood-oxygenation-level-dependent (BOLD), tissue-oxygenation-level-dependent (TOLD) and dynamic contrast-enhanced (DCE)-MRI. Histogram characteristics [central tendency (mean, median) and heterogeneity (standard deviation, kurtosis, skewness) MRI parameters] in HCC and liver parenchyma were compared using Wilcoxon signed-rank tests. Histogram data was correlated between MRI methods in all patients and with histopathology and gene expression in 14 patients.

RESULTS

HCCs exhibited significantly higher intra-tissue heterogeneity vs. liver with all MRI methods (P<0.042). Although central tendency parameters showed significant correlations between MRI methods and with each of histopathology and gene expression, heterogeneity parameters exhibited additional complementary correlations between BOLD and DCE-MRI and with histopathologic hypoxia marker HIF1a and gene expression of Wnt target GLUL, pharmacological target FGFR4, stemness markers EPCAM and KRT19 and immune checkpoint PDCD1.

CONCLUSION

Histogram analysis combining central tendency and heterogeneity mpMRI features is promising for noninvasive HCC characterization on the imaging, histologic and genomics level.

CLINICAL RELEVANCE/APPLICATION

The proposed mpMRI approach could potentially be used to stratify hepatocellular carcinoma treatment and to noninvasively predict treatment outcome.

SSJ07-06 Prediction of Target Therapy Related Gene Expression Level for Hepatocellular Carcinoma: Preoperative Gd-EOB-DTPA Enhanced MRI and Histopathological Correlation

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E350

Participants
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PURPOSE

Our aim of the study is to investigate the feasibility of prediction for target therapy related gene expression level in hepatocellular carcinoma (HCC) using preoperative Gd-EOB-DTPA enhanced magnetic resonance imaging (MRI).

METHOD AND MATERIALS

91 patients with solitary HCC who underwent preoperative Gd-EOB-DTPA enhanced MRI were prospectively analyzed. Features including tumor size, signal homogeneity, tumor capsule, tumor margin, intratumoral vessels, peritumor enhancement in mid-arterial phase, peritumor hypointensity during hepatobiliary phase, signal intensity ratio on DWI and apparent diffusion coefficients (ADCs), T1 relaxation times and the reduction rate between pre- and post-contrast enhancement images were assessed. HCC target therapy related gene (B-Raf,Raf-1,VEGFR2,VEGFR3) expression level in excision specimens were evaluated using immunohistochemical staining. Correlation between these MRI features and B-Raf,Raf-1,VEGFR2,VEGFR3 gene expression level were analyzed by Rank sum test, Spearman correlation and multivariate logistic regression so as to establish a prediction model.

RESULTS

Univariate analysis showed that tumor incomplete or non capsule (p<0.001), intratumoral vessels (P=0.002) were significantly related with the B-Raf gene expression level, and tumor capsule status (p=0.001), intratumoral vessels (P=0.013) significantly correlated with the Raf-1 gene expression level. There was no significant association between the expression level of VEGFR2, VEGFR3 and all the MRI features. Multivariate logistic regression analysis demonstrated that incomplete tumor capsule (P=0.002, OR=11.870, 95% CI: 2.473~56.975) or non capsule (P=0.004, OR=15.750, 95% CI: 2.373~104.537) were independent risk factors of HCC with high B-Raf gene expression level, and incomplete tumour capsule (P< 0.001, OR=11.250, 95%CI: 3.206~39.474) or non capsule (P=0.040, OR=5.556, 95%CI: 1.078~28.635) were independent risk factors of HCC with high Raf-1 gene expression level.

CONCLUSION

It is feasible to predict the expression level of B-Raf and Raf-1 gene using preoperative Gd-EOB-DTPA enhanced MRI.

CLINICAL RELEVANCE/APPLICATION

Incomplete or non capsule, or presence of intratumoral vessels are potential indicator for the high expression of B-Raf and Raf-1. Gd-EOB-DTPA enhanced MRI may facilitate the determination for choosing gene therapy for the patient with HCC.

RSNA 2017 Explore. Invent. Transform.
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SSJ08

Gastrointestinal (Liver-Fat/Iron)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353A

BQ CT GI MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Scott B. Reeder, MD, PhD, Madison, WI (*Moderator*) Institutional research support, General Electric Company; Institutional research support, Bracco Group; Founder, Calimetrix, LLC; Shareholder, Elucent Medical
Sheela Agarwal, MD, MS, New York, NY (*Moderator*) Employee, Bayer AG

Sub-Events

SSJ08-01 Comparison of Fat Quantification Accuracy between Spectral CT Imaging and IDEAL-IQ Techniques: A Phantom Study

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E353A

Participants
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PURPOSE

In this study, we used spectral CT with fat material decomposition technique and magnetic resonance (MR) IDEAL-IQ to quantify fat content. The goal of this study was to evaluate the accuracy of the two methods at different fat concentrations.

METHOD AND MATERIALS

(1) For the fat-water model (model A), a series of concentrations containing homogeneous mixed fat and water were prepared, with a fat content of 0.00, 0.02, 0.04, 0.08, 0.16, 0.32, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, 1.00 ml/ml, respectively. For the liver-fat model (model B), eleven homogeneous liver and fat tissue mixed samples with various fat content from 0-1.0 g/g (with an interval of 0.1 g fat/g). (2) All samples were scanned on GE Discovery HD750 CT. Fat material decomposition technique (water-fat base) was further applied to measure the fat density (MFD). IDEAL-IQ was utilized on GE Discovery 750w MR scanner to obtain the measured fat fraction (MFF). A linear regression was performed to analyze the relationship between the MFD or MFF and the actual fat fraction (AFF).

RESULTS

Both spectral CT fat material decomposition method and MR IDEAL-IQ method resulted good linear relationship between the measured fat content and AFF. In model A, it showed as: R2MFD=0.9936, R2MFF=0.9987. In Model B, it showed as: R2MFD=0.9946, R2MFF =0.9941. For Both models it had a P value less than 0.001. In particular at a lower fat concentration range in model A (AFF between 0-16%), the results were R2MFD=0.8927 and R2MFF=0.9687. In this circumstances, MFF showed a stronger linear correlation with AFF compared to MFD while MFD value can be well normalized to obtain AFF by the corresponding correlation equation.

CONCLUSION

Both spectral imaging fat material decomposition and MR IDEAL-IQ techniques can provide accurate and reliable quantification of fat content for both water-fat and liver-fat models. In particular, MFF has a more significant correlation with AFF in the low fat content scenario.

CLINICAL RELEVANCE/APPLICATION

This study demonstrated the feasibility of using CT spectral imaging - fat material decomposition and MR IDEAL-IQ technique to precisely quantify the fat content. The results indicated promising clinical applications of using these methods to study the fat metabolism in different tissues or organs (e.g. brain, breast, liver and bone) that contain different fat concentration in the future.

SSJ08-02 Automated Prediction of Nonalcoholic Fatty Liver Disease Activity Score (NAS) with an Advanced Multiparametric Magnetic Resonance Elastography and Machine Learning Technology

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E353A

Participants
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PURPOSE

Liver stiffness has become the most accurate noninvasive imaging biomarker for detecting hepatic fibrosis. However, much less work has been done for assessing the NAFLD activity score (NAS) - which is a numerical sum of histologic grading of steatosis, inflammation, and ballooning in biopsy specimens. In animal models, we have found that the NAS can be predicted by training a machine learning algorithm with data sets of multiple parameters obtained from MR elastography (MRE) (e.g., storage and loss moduli, volumetric strain) and MRI-assessed proton density fat fraction (PDFF). In this study, we tested the same approach in a pilot clinical study to assess the potential to predict the NAS using multiparametric MRE.

METHOD AND MATERIALS

62 clinically obese patients who underwent bariatric surgery and 12 normal volunteers (BMI<30) were included. Multifrequency MRE was used to measure the various mechanical properties that correlate with ballooning and inflammation, while PDFF was used to quantify steatosis. Liver biopsies were obtained in patients for histologic grading and calculating NAS based on the NASH CRN criteria. From the MRE/MRI parameters, the three parameters that best and most significantly correlated with NAS were selected ($p<0.05$ for all three parameters). Several machine learning regression algorithms were tested to minimize cross-validation error in the training set. An ordinal logistic model was used for ordinal NAS outputs in a confusion matrix with subsequent ROC analyses.

RESULTS

The clinical model included 74 subjects: 62 obese (35 NAFLD and 27 NASH) and 12 healthy volunteers. Liver stiffness at 60 Hz, loss modulus at 30 Hz, and fat fraction were all significantly associated with the NAS in the effect tests for both linear and nonlinear (neural networks) predictions (Fig. a,b). The ordinal logistic model showed less than ±1 bias in 93% of subjects (69/74) in the resulting confusion matrix (Fig. c) and successfully distinguished each NAS score with excellent accuracy (AUROC>0.9 for all, Fig. d).

CONCLUSION

This preliminary study shows that multiparametric MRE/MRI can be used to accurately predict NAS score and represents a promising alternative to liver biopsy for NASH diagnosis and monitoring.

CLINICAL RELEVANCE/APPLICATION

Multiparametric MR elastography, coupled with machine learning, can provide a noninvasive prediction of the NAFLD activity score (NAS), which is an important metric for assessing disease severity.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Richard L. Ehman, MD - 2016 Honored EducatorSudhakar K. Venkatesh, MD, FRCR - 2017 Honored Educator

SSJ08-03 A Simple Template-Matching Method for Liver Proton-Density Fat Fraction Determination by Multiecho Gradient-Echo MR Imaging

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E353A

Participants
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PURPOSE

Proton-density fat fraction (PDFF) is an accepted quantitative imaging biomarker of liver steatosis. However, the complexity of PDFF calculation by nonlinear curve-fitting has been a barrier to more widespread adoption. The purpose of this study was to validate a simple template-matching method for liver PDFF determination as an alternative to the conventional curve-fitting method.

METHOD AND MATERIALS

This is a secondary analysis of an IRB-approved, HIPAA-compliant clinical trial of diabetic adults undergoing liver MRI. Liver MRI

This is a secondary analysis of an IRB-approved, HIPAA-compliant clinical trial of diabetic adults undergoing liver MRI. Liver MRI exams were performed at 3T using 3D spoiled gradient echo sequence, acquired at 6 echo times (TEs): 1.05, 1.84, 2.63, 3.42, 4.21, 5.01ms. The T1-bias was minimized by flip angle 2 deg for repetition time 6.2ms. On the reconstructed magnitude images, a region of interest (ROI) was placed on the liver. ROI's mean signal magnitudes were recorded for each TE.The multiecho data were analyzed by two different methods: conventional nonlinear curve-fitting using a multipeak fat spectral model, and template-matching, as follows. First, a library of signal templates (synthetic 6-element signal vectors) was pre-generated for a 2D parameter grid: PDFF 0-50% and R2* 0-1000ms. Second, the observed 6-echo signal vector was compared to each template by vector inner-product. The template resulting in the maximum inner-product was selected as the "match". Computation times for both methods were recorded.

RESULTS

51 subjects (mean age 35 yrs, range [36-71] yrs) underwent liver MRI, 40 of which completed both pre- and post-treatment MRI. All available 91 MRI exams were analyzed. Figure 1 shows near-perfect linear regression agreement between the template-matching and curve-fitting liver PDFF values. The intercept and slope were slightly different from 0 and 1, respectively (p=0.006 and <0.001), but their small effect sizes are likely not clinically relevant. Bland-Altman (Figure 2) analysis demonstrates that template-matching has <1% error margin in absolute PDFF. Per-ROI computation time was 0.9ms and 19.6ms for template-matching and curve-fitting, respectively.

CONCLUSION

Liver PDFF calculation using template-matching is equivalent to curve-fitting within 1% error margin in absolute PDFF.

CLINICAL RELEVANCE/APPLICATION

Template-matching permits simple liver PDFF calculation without complex nonlinear curve-fitting and may facilitate more widespread use worldwide.

SSJ08-04 Dual-Layer Detector Spectral CT versus Magnetic Resonance Imaging for the Assessment of Iron Overload in Myelodysplastic Syndromes and Aplastic Anemia

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E353A

Participants
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PURPOSE

To investigate the performance of dual-layer detector spectral CT for iron deposition in myelodysplastic syndromes and aplasic anemia,and to compare the results to MRI T2* imaging

METHOD AND MATERIALS

Thirty patients with clinical history of myelodysplastic syndromes and aplasic anemia underwent T2*-weighted hepatic and cardiac MRI on a three-tesla MRI scanner (Ingenia, Philips, Netherlands) and were scanned on a 128-row spectral detector CT (IQon, Philips, Netherlands) latterly. T2* values of liver and septal muscle were calculated with a dedicated software tool (CMR Tools©, Imperial College). HU differences (ΔHU) in liver and septal muscle were calculated between the lower (50 kVp) and higher (120 kVp) energy resulted from mono-energetic spectral imaging ranging from 40 to 200 keV, which was based on spectral base image (SBI). Regression and correlation analyses were conducted between T2* and HU differences (ΔHU) in the liver and cardiac muscle.

RESULTS

Table time for spectral CT was significantly shorter compared to MRI (mean: 3.3 min vs. 25.2 min). Liver and cardiac T2* were 13.68 ± 12.52, 27.89 ± 35.01ms,respectively. Liver and cardiac signal intensity ratio to muscle were 0.650.44,1.44 ± 0.60,respectively. Liver and cardiacΔHU were 3.12 ± 1.89, 2.35 ±2.89 Hu, respectively. The results showed strong (r = 0.8 and P <0.05) linear correlation between liver T2* and liver ΔHU, and moderate linear correlation (r = 0.61 and P <0.05) between cardiac T2* and cardiac ΔHU. Strong linear correlation (r = 0.85 and P <0.05) was found between liver to muscle (L/M) signal intensity ratio and ΔHU, and moderate linear correlation (r = 0.65 and P <0.05) between heart to muscle (H/M) signal intensity ratio and cardiac ΔHU.

CONCLUSION

Dual-layer detector spectral CT seem to be equivalent valuable for evaluating liver and myocardial iron overload, compared to MRI T2* imaging, which might help in patient staging based on the severity of iron overload.

CLINICAL RELEVANCE/APPLICATION

Dual-layer detector spectral CT might help in patient with iron overload.

SSJ08-05 Non-invasive Quantification and Grading of Liver Iron Content with Spectral CT: An Iron Overload Rabbit Model Study

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E353A

Participants
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PURPOSE

To assess the accuracy of spectral CT in liver iron concentration (LIC) quantification and grading at different clinically significant LIC thresholds.

METHOD AND MATERIALS

Fifty-one rabbits of iron-loaded model were established by intravenous injection of iron dextran. Abdomen CT was then performed with fast kilovolt peak switching dual energy CT. Hepatic iron concentration (HIC) imaging was derived from an iron/water, two-material decomposition using gemstone spectral imaging analysis. Hepatic attenuation on 40 Kev and 140 Kev monochromatic energy image were measured. The difference between 40 Kev and 140 Kev (ΔH) was calculated. Ex vivo hepatic pathology was obtained and postmortem assessment of LIC was conducted on inductively-coupled plasma (ICP) spectrometer. The correlations between CT measurements (HIC and ΔH) and LIC were analyzed. HIC was fitted against LIC to build linear regression. Then the prediction accuracy of the regression was tested. Diagnostic performance of HIC and ΔH in discriminating different LIC thresholds (1.8, 3.2, 7.0, 15.0mg/g dry tissue) were evaluated by receiver operating characteristic (ROC) analysis.

RESULTS

According to the pathological analysis, the iron staining increased with increasing dose of injected dextran iron. LIC was from 0.20 to 39.59mg/g measured by ICP. HIC (range, -37.41-118.03 mg/mL) had a positive linear correlation with LIC(r^2=0.943,P<0.001). The predicted HIC obtained by derived equation calculation showed a high consistency with ICP results. For discriminating clinically significant LIC thresholds (1.8, 3.2, 7.0, 15.0mg/g dry tissue), ROC analysis revealed that the corresponding optimal cutoff value of HIC was -17.56, -0.92, 7.6, 48.28 mg/mL. With the cutoff value of HIC= 48.28 mg/mL, the highest sensitivity (100%) and specificity (100%) were obtained at LIC threshold of 15.0mg/g dry tissue. HIC showed no significant differences with ΔH at different clinically iron accumulation thresholds (P>0.05).

CONCLUSION

HIC was highly linear with titrated LIC in the iron overload rabbit models. HIC could quantify LIC and had high accuracy for grading LIC especially at graveness iron accumulation situation.

CLINICAL RELEVANCE/APPLICATION

With excellent diagnostic performance for discriminating clinically significant LIC thresholds, HIC imaging might be used to guide iron chelation therapy in the clinical practice in the future.

SSJ08-06 Virtual Unenhanced Algorithms for Fast-Kilovolt Switching Dual-Energy CT: Comparison Between Dedicated and Non-dedicated Softwares for Assessment of Liver Fat Content

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E353A

Participants
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PURPOSE

In fast kV-switching dual-energy CT (DECT), a new multi-material decomposition (MMD) algorithm developed for the quantification of liver fat content includes virtual unenhanced (VUE) algorithm based on the attenuation coefficient of liver tissue. This study aims to compare the accuracy of the dedicated and non-dedicated VUE algorithms for liver fat content estimation.

METHOD AND MATERIALS

Forty-seven patients with suspected hepatic steatosis (BMI, 18-40) underwent unenhanced and tri-phase dynamic contrast-enhanced DECT scans within 4 weeks prior to liver biopsy. Hepatic fat volume fraction (FVF, %) images using MMD and CT attenuation value (CTav, HU) images using non-dedicated VUE were generated from DECT data. FVF and CTav were compared with histologic steatosis grade (0-3, as defined by the non-alcoholic fatty liver disease activity score [NAS] system) using Jonckheere-Terpstra trend tests. Agreement of the measurement between real- and virtual unenhanced images was assessed using generalized estimating equation (GEE) model and Bland-Altman analysis.

RESULTS

NAS steatosis scores were score 0 in 11 patients; 1 in 21; 2 in 12; and 3 in 3. FVF increased and CTav decreased with increasing histologic steatosis grade (trend test, P < .001 for each). GEE models revealed that scan phase was significantly associated with CTav (ß = 0.8; P < .016) but not with FVF (ß = 0.06; P =.730). The differences between real non-contrast-enhanced and contrast-enhanced FVFs for arterial, portal venous, and equilibrium phases tended to be larger (limits of agreement, -8.4 to 9.5) but there was no systemic bias. Bland-Altman analysis of real non-contrast-enhanced and each of three contrast-enhanced CTav showed significant proportional bias (r = -0.38 to -0.44; P < .001 for all).

CONCLUSION

VUE in MMD algorithm for the quantification of liver fat content is more accurate than CT attenuation value calculated with non-dedicated VUE.

CLINICAL RELEVANCE/APPLICATION

The MMD algorithm is a promising technique for less-invasively assessment of hepatic fat content, as fat volume fraction data can be derived from the contrast-enhanced scan, eliminating the need for a separate non-contrast CT scan to derive fat volume fraction.

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SSJ09

Gastrointestinal (Biliary Imaging)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353C

GI MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ09-01 Novel Radiologic Model to Predict Disease Severity of Primary Sclerosing Cholangitis: Association of Quantitative Liver Volume with Mayo Risk Score

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E353C

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the association of absolute total liver (T), lobar (right and left; R, L), and caudate volume (C), as well as ratios of left lobe and caudate to total liver volume (L/T and C/T) with the disease severity of PSC as determined by Mayo score. The second aim was to develop a novel radiologic model to predict Mayo score.

METHOD AND MATERIALS

This HIPAA compliant, retrospective single center study included 79 PSC patients who were imaged between 2000 and 2017. T, R, L and C were measured using Advantage Workstation (GE) on the imaging study (MR/CT) within an average of 4 months of risk score calculation. L/T and C/T ratios were then calculated. Patients were stratified into group A (low and intermediate risk; Mayo score <2) and group B (high risk; Mayo score >=2). The differences in liver volumes between the 2 groups were assessed using T test. Regression analysis was performed to test the correlation between the liver volumes and Mayo score. To assess the prognostic performance of liver volume, area under the receiver operating characteristic (AUC-ROC) curve was evaluated. P value <0.05 was considered significant.

RESULTS

Our cohort included 49 males and 30 females with the mean age of 43, with no significant differences in age between males and females (p=0.74). T, L, and C were significantly higher in group B than in group A (p<0.05). However, the difference in R was not significant (p=0.07). The differences of L/T and C/T between Group A and B were statistically significant (p<0.005). L/T had the best positive correlation with Mayo score (r=0.55). Linear regression analysis identified L/T as a significant variable for predicting Mayo score, with the prediction model as follows (p<0.001): Mayo risk score= 5.6*(L/T) - 1.5 L/T showed good ability to distinguish between mild/moderate and severe PSC patients (AUC-ROC 0.8).

CONCLUSION

Patients with severe PSC have larger total liver, left lobe, and caudate volume, and higher left and caudate to total ratio compared to patients with mild/moderate disease. Left lobe to total liver volume ratio was associated with Mayo score and it may be used to predict disease severity in patients with PSC.

CLINICAL RELEVANCE/APPLICATION

Novel volumetric liver measurements correlate with Mayo scores and may potentially be useful in supplementing Mayo score and predicting disease severity.

SSJ09-02 Postprandial Changes in Flow Dynamics of the Bile within the Common Bile Duct: Evaluation with Cine Dynamic MRCP and a Spatially Selective IR Pulse

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E353C

Participants
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PURPOSE

To evaluate the influence of oral ingestion in flow dynamics of the bile within the common bile duct in healthy subjects by using cine dynamic MRCP and a spatially selective IR pulse non-invasively.

RESULTS

The median grading score of antegrade bile flow after oral ingestion (score=0.85-1.18) was significantly (P<0.01) higher than that before oral ingestion (score=0.53), indicating that bile excretion was stimulated by oral ingestion. Grading score of antegrade bile flow showed a maximum peak of 1.18 at 26 minutes after ingestion, and then, began to gradually decline with a statistical difference (P<0.01). Contraction of gallbladder was associated with increased grading score of antegrade bile flow after oral ingestion with a statistical significance (p<0.01). Regarding reversed bile flow, there were no significant differences in median grading score before (0.18) and after (0.15-0.23) oral ingestion, suggesting that oral ingestion has little affect on the function of oddi sphincter.

CONCLUSION

Non-invasive cine dynamic MRCP using spatially selective IR pulse showed potential for evaluating postprandial changes of flow dynamics of bile as a physiological reaction.

CLINICAL RELEVANCE/APPLICATION

Cine dynamic MRCP using spatially selective IR pulse may contribute to the assessment of flow dynamic changes of the bile such as the impaired bile excretion in patients with digestive malabsorption.

SSJ09-03 Intrahepatic Cholangiocarcinoma: Can Imaging Phenotypes Predict Survival and Tumor Genetics?

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E353C

Participants
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PURPOSE

On CT, intrahepatic cholangiocarcinomas (ICC) are phenotypically heterogeneous tumors. The purpose of this study was to investigate the associations between CT imaging phenotypes, patient survival and known genetic markers. We hypothesize that visibly different tumor subtypes may be associated with survival or known genetic pathways of ICC.

METHOD AND MATERIALS

An institutional review board approved,HIPAA-compliant,retrospective study was performed with 66 patients who had surgically resected ICC. Preprocedure CT images of ICC were assessed using predominantly qualitative radiographic descriptors while blinded to tumor genetics and patient clinical data. Associations between radiographic features and overall survival (OS) and disease free survival (DFS) were performed with Cox proportional hazards regression and visualized with Kaplan Meier plots. The associations between radiographic features and imaging pathways (IDH1, Chromatin and RAS-MAPK) were assessed with Fisher's Exact test and the Wilcoxon Rank sum test, where appropriate and corrected for multiple comparisons within each pathway using the False Discovery Rate correction.

RESULTS

Three imaging features were significantly associated with a higher risk of death: necrosis (HR:2.95 95%CI:1.44-6.04, p=0.029), satellite nodules (HR:3.29, 95%CI:1.35-8.02, p=0.029), and vascular encasement (HR:2.63, 95%CI:1.28-5.41, p=0.029). Additionally, with each increase in axial size, the risk of death increased (HR:1.14, 95%CI:1.03-1.26, p=0.029). Similar to findings for OS, satellite nodules (HR:3.81, 95%CI:1.88-7.71, p=0.002) and vascular encasement (HR:2.25, 95%CI:1.24-4.06, p=0.019) were associated with increased risk of recurrence/death. No significant associations were found between radiographic features and genes in the IDH1, Chromatin or RAS-MAPK pathways (p=0.63-84).

CONCLUSION

This preliminary analysis of resected ICC suggests associations between CT imaging features and OS and DFS. No association was identified between imaging features and currently known genetic pathways.

CLINICAL RELEVANCE/APPLICATION

Intrahepatic cholangiocarcinomas are heterogeneous on CT and have qualitative radiographic features associated with survival. Possible associations with tumor genetics were not identified.

SSJ09-04 Multiparametric Response Assessment of Unresectable Intrahepatic Cholangiocarcinoma Treated with TACE: Role of Contrast Enhanced 3-D Volumetric Functional MRI Using Apparent Diffusion Coefficient Maps

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E353C

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PURPOSE

To assess multiparametric changes in 3-D volumetric functional parameters on contrast enhanced MRI and DWI in predicting early response of unresectable intrahepatic cholangiocarcinoma (iCCA) after transcatheter arterial chemoembolization (TACE).

METHOD AND MATERIALS

This retrospective IRB-approved, HIPAA-compliant study with waived patient consent included 94 patients (mean age, 68±12 years; 40 men) with unresectable iCCA. All patients underwent baseline and follow up MRI after TACE, and were followed up until death or December 2016. Index lesions were analysed for changes in anatomical (RECIST, volume) and functional (viable tumor, tumor burden, ADC) volumetric MR parameters. Overall survival (OS) was used to stratify cohort into low (<=15 months) and high (>15 months) OS groups. Changes in MRI and confounding clinical parameters were compared between the two groups. Their effect on OS was assessed using Cox-regression and Kaplan-Meier analysis. P <0.05 was considered significant.

RESULTS

Tumor volume did not show significant change after TACE (P=0.07) while RECIST diameter showed a small change (-2.6 mm, P=0.02). Mean absolute and percent viable tumor volume, and mean tumor burden decreased (P<0.0001, for each) while mean ADC increased (P<0.0001) after TACE. The only parameter showing significantly different change between low and high OS groups was mean ADC, both absolute (215.4±260.5 x 10-6 mm2/s vs 341.9±313.5 x 10-6 mm2/s; P=0.040) and percent (12.8±14.7 % vs 28.8±27.4 %; P=0.001) change. In Cox regression analysis, significant effect on survival outcomes was seen for percent ADC change adjusted for confounding clinical parameters. (Hazard ratio, 0.93; P<0.05). Significant differences in survival were noted when percent change in mean ADC cut off of 25%, 30% and 35% were used to classify responders and non-responders (log rank test, P=0.035, 0.019 and 0.001, respectively).

CONCLUSION

After TACE, iCCA lesions showed increase in volumetric ADC (19.9%), decrease in viable tumor volume (25.9%), and decrease in percent viable tumor volume (16.3%). Thresholds of 25%, 30% and 35% change in ADC resulted in survival differences with a 7% reduction in risk of death for a unit increase in percent ADC change.

CLINICAL RELEVANCE/APPLICATION

Volumetric functional MR changes can allow individualization of TACE therapy in iCCA with prediction of early oncologic response and overall survival. These may be utilized in future clinical trials.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ihab R. Kamel, MD, PhD - 2015 Honored Educator

SSJ09-05 Influence of Cholecystectomy on the Flow Dynamic Pattern of Bile in the Extrahepatic Bile Duct: Assessment by Cine-Dynamic MRCP with Spatially-Selective IR Pulse

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E353C

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PURPOSE

To evaluate the influence of cholecystectomy on the flow dynamic pattern of bile in the extrahepatic bile duct by using cine-

dynamic MRCP with spatially-selective inversion-recovery (IR) pulse non-invasively.

RESULTS

Antegrade bile flow was observed more frequently in the cholecystectomy group than in the non-cholecystectomy group (5.1 times vs 2.9 times, P=0.005). Mean grading score of antegrade bile flow was significantly greater in the cholecystectomy group than in the non-cholecystectomy group (mean grade, 0.33 vs 0.21; P=0.007). These facts suggested that antegrade bile flow is probably generated by increased intraductal pressure of CBD collecting bile, and that the common bile duct plays function of the gallbladder such as contraction and buffering. Regarding reversed bile flow, there were no significant differences in the frequency and grading score between cholecystectomy group and non-cholecystectomy group, suggesting that contraction pressure in the sphincter of Oddi is extremely higher than CBD pressure even in patients after cholecystectomy.

CONCLUSION

Antegrade bile flow was observed more frequently and predominantly in patients after cholecystectomy in cine-dynamic MRCP with a spatially selective IR pulse probably due to the increased intraductal pressure of CBD collecting the bile while reversed bile flow was observed equivalently because of the preserved function of Oddi sphincter.

CLINICAL RELEVANCE/APPLICATION

Cine-dynamic MRCP with a spatially selective IR pulse may play a role in evaluating the alteration of bile flow pattern in patients with postcholecystectomy syndrome and sphincter of Oddi dysfunction.

SSJ09-06 Can MRI Distinguish Between Hepatocellular Carcinoma, Intrahepatic Cholangiocarcinoma and Biphenotypic Tumors?

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E353C

Participants
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PURPOSE

Accurate differentiation between hepatocellular carcinoma (HCC), intrahepatic cholangiocarcinoma (ICC) and biphenotypic tumors (BPT) at imaging is clinically important but often a challenge. The purpose of this multi reader study was to assess the ability of contrast enhanced multiphase MRI to differentiate between HCC, ICC, and BPT.

METHOD AND MATERIALS

Patients with histologically confirmed HCC, ICC or BPT and who had undergone liver MRI were identified using pathology and radiology databases. Patients with therapy prior to imaging were excluded. MRI studies were reviewed by 4 abdominal radiologists blinded to tumor type. Disagreement was resolved by majority and if necessary, a blinded fifth reader. Readers reviewed imaging findings of each tumor on T2W, DWI and T1W images. Dynamic enhancement (arterial, portal and delayed phase) characteristics were reviewed and 1 of 4 enhancement patterns (see figure) was assigned to each tumor. The most likely diagnosis (HCC, ICC or BPT) was recorded. Fisher's exact test was used to compare proportions. Krippendorff's a was used to compare variability amongst readers.

RESULTS

MRI exams from 50 patients (age 64±12 years, 19M, 31F) with 24 HCC, 20 ICC and 6 BPT were included. 20 (83%) HCC, 3 (50%) BPT and 19 (95%) ICC were correctly identified. 21 (88%) HCC had type 1 and 18 (90%) ICC had type 2 enhancement pattern while BPT showed a mix of type 1 (33%), type 2 (50%) and type 4 (17%) enhancement. Type 1 was seen more frequently in HCC than ICC or BPT and type 2 was seen more frequently in ICC than in HCC. Rate of T2 hyperintensity was seen more frequently in ICC than BPT (100% vs 66%), while washout was seen more frequently in HCC compared to either BPT and ICC (83% versus 0% and 5% respectively). Capsule was seen more frequently in HCC than ICC (58% vs 5%) ($p<0.05$ for all listed comparisons). Krippendorff's a ranged from 0.308 to 0.515 for individual findings and was 0.739 for final diagnosis.

CONCLUSION

While characteristic enhancement patterns allow accurate diagnosis of HCC and ICC, BPT were more diverse in their enhancement pattern and therefore more difficult to diagnose. BPT should be considered in the differential diagnosis of a hepatic mass which lacks characteristic features of HCC or ICC such as T2 hyperintensity, washout or capsule.

CLINICAL RELEVANCE/APPLICATION

Biphenotypic tumors cannot be accurately differentiated from HCC and ICC using multiphasic MRI.

SSJ10

Genitourinary (Imaging of Pregnancy)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E351

GU MR OB

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ10-01 Symptomatic Fibroids in Pregnancy: MR Imaging Features and Differentiation from Non-Symptomatic Fibroids

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E351

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate MRI findings of symptomatic fibroids causing acute lower abdominal and/or pelvic pain in pregnancy and compare them with non-symptomatic fibroids.

METHOD AND MATERIALS

MRI studies of pregnant patients with uterine fibroids performed for acute lower abdominal and/or pelvic pain between 1/2010-9/2016 were retrospectively evaluated. Patient age, gestational age, fibroid size, fibroid number, fibroid location, signal intensity of the fibroid relative to myometrium on T1- weighted imaging, T2-weighted imaging, and diffusion weighted imaging (DWI), and ADC values were recorded along with final discharge diagnoses. Kruskal-Wallis and chi-squared tests compared continuous and categorical variables, respectively, between symptomatic and non-symptomatic fibroids.

RESULTS

Twenty-seven pregnant patients (mean age of 33 [range: 24-47] and mean gestational age of 18 [range: 4-33]) with a total of 57 fibroids comprised the study cohort, with 13 fibroids in 13 patients ultimately identified as the cause of pain based on clinical examination and final discharge diagnoses. Larger size (5.8 versus 3.4 cm in diameter, $p = 0.00012$), T2 hyperintensity relative to myometrium ($p = 0.000049$), and hyperintensity on DWI ($p = 0.00054$) were significantly associated with symptomatic fibroids. ADC values were slightly lower in symptomatic fibroids but not statistically significant (1401 versus 1493 x 10-6 mm2/s, $p = 0.32$). No difference in T1 signal intensity was seen between symptomatic and non-symptomatic fibroids ($p = 0.73$).

CONCLUSION

MRI characteristics of fibroids causing acute pain in the setting of pregnancy have not previously been described, with the exception of T1 hyperintensity seen with red degeneration. In our cohort, larger size and hyperintensity on DWI and T2-weighted imaging relative to myometrium are significantly associated with symptomatic fibroids. These imaging features may also be useful indicators of fibroid degeneration.

CLINICAL RELEVANCE/APPLICATION

MR signal characteristics associated with symptomatic fibroids are described in our cohort of pregnant patients presenting with acute pain, and may be useful indicators of fibroid degeneration.

SSJ10-02 Malformations of Cortical Development Associated with Corpus Callosum Dysgenesis (CCD): Diagnostic Value of Fetal MRI in Prenatal Counseling

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E351

Awards
Student Travel Stipend Award

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PURPOSE

To define the diagnostic role of fetal MRI in the assessment of cortical dysplasias and other malformations of the developing cerebral cortex, in fetuses with different forms of Agenesis of the Corpus Callosum (ACC).

METHOD AND MATERIALS

104 MR images of fetal CNS with a US suspicion of ACC were retrospectively reviewed. Fetal MRI was performed at 1.5 T Magnetom Avanto (Siemens, Erlangen, Germany) without mother-fetal sedation. Polymicrogyria, lissencephaly, schizencephaly, subependymal heterotopias and migration disorders were evaluated. Cortical findings were compared to three types of ACC (complete agenesis, partial agenesis and hypoplasia). Genetic tests were collected. Post-natal MRI or fetopsy for diagnostic confirmation were collected.

RESULTS

On 104 fetuses, fetal MRI was able to detect cortical malformations in 32 cases even in early gestational ages (<24GW). The mean Gestational Weeks (GW) at MR diagnosis was 26 (range: 22-36GW). MR imaging found 13/32 polymicrogyria, 7/32 lissencephaly, 5/32 schizencephaly, 4/32 subependymal heterotopias and 3/32 neuronal migration disorders. 22/32 had complete ACC, 4/32 had partial ACC and 6/32 had CC hypoplasia. Statistically significant correlations ($p<0.005$) between complete ACC, focal polymicrogyria and cortical dysmorphism affecting frontal lobes were found.

CONCLUSION

Fetal CNS MRI can detect cortical development malformations in complex ACC, providing further information for the clinician to assess the severity of perinatal outcome.

CLINICAL RELEVANCE/APPLICATION

MRI is a useful tool in improving obstetrical genetic prenatal counselling to predict pregnancy and fetal prognosis.

SSJ10-03 The Safety of MR Imaging at 3.0 T in Fetuses: Is Fetal Birth Weight or Hearing Impaired?

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E351

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the effects of magnetic resonance imaging at 3.0 T during pregnancy on fetal growth and neonatal hearing in healthy newborns who are at low risk for congenital hearing impairment and brain or chromosomal abnormalities.

METHOD AND MATERIALS

This single-center retrospective case-control study was IRB approved. Informed consent was waived. 81 consecutive healthy newborns who were exposed to MR imaging at 3.0 T while in utero and were born between January 2011 and January 2016 were included. Each MR exposed newborn was matched 1:2 by birth date to a randomly selected healthy control newborn who was not exposed to MR imaging as a fetus. A total of 162 control newborns were included. For each MR exposed newborn, the estimated gestational age at MR exposure was recorded. For each MR exposed and control newborn, infant birth weight was recorded. In concordance with national guidelines, neonatal hearing screening was performed using auditory brain stem response. All hearing tests for the MR exposed and control neonates were recorded. Comparison of the average birth weight between the two groups was performed using an unpaired Student *t* test. The prevalence of hearing impairment was compared between the two groups by using Fisher's exact test.

RESULTS

The average estimated gestational age of fetal MR exposure was 148 days (range 35 days to 265 days). There was no significant difference in average birth weight between the MR exposed and control neonates; 3398 grams vs. 3510 grams, respectively [P = 0.06]. The prevalence of hearing impairment in the MR exposed neonates was 0% (0 out of 81); the prevalence of hearing impairment in the control group was 1.8% (3 out of 162). There was no significant difference between the two groups [P =0.55].

CONCLUSION

This study showed no evidence that fetal exposure to MR imaging at 3.0 T is associated with fetal growth restriction or neonatal hearing impairment.

CLINICAL RELEVANCE/APPLICATION

The data from this study suggests that fetal exposure to MR imaging at 3.0 T is safe.

SSJ10-04 Use of a Telerobotic Ultrasound System for Prenatal Imaging

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E351

Awards
Trainee Research Prize - Resident

Participants
Scott J. Adams, MD, Saskatoon, SK (*Presenter*) Nothing to Disclose
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PURPOSE

To determine the feasibility of using a telerobotic ultrasound system to remotely perform prenatal ultrasound examinations and generate images of diagnostic quality, and determine the acceptability of the system to patients and sonographers.

METHOD AND MATERIALS

Thirty participants (mean gestational age 22.8 weeks, range 15-36 weeks) were prospectively recruited. Participants underwent a limited examination (consisting of biometry, placental location, and amniotic fluid; n=21) or detailed examination (biometry, placental location, amniotic fluid, and fetal anatomic survey; n=9) performed using a conventional ultrasound system (EPIQ 5, Philips). This was immediately followed by an equivalent examination performed by a different sonographer using a telerobotic system consisting of a robotic arm (MELODY System, AdEchoTech), ultrasound unit (SonixTablet, BK Ultrasound), and videoconferencing system. Using this system, radiologists or sonographers remotely control all ultrasound settings and fine movements of a transducer from a distance. Telerobotic images were read independently from conventional images. Patients and sonographers were surveyed to assess acceptability of the system.

RESULTS

A paired sample t-test showed no statistically significant difference between conventional and telerobotic measurements of fetal head circumference or single deepest vertical pocket of amniotic fluid; however, a small but statistically significant difference was observed in measurements of biparietal diameter, abdominal circumference, and femur length (p-values <0.05). Intraclass correlations displayed excellent agreement (>0.90) between telerobotic and conventional measurements of all four biometric parameters. Of 21 fetal structures included in the anatomic survey, 82% (range 68-100%) of the structures attempted were sufficiently visualized using the telerobotic system. Ninety-seven percent of patients strongly or somewhat agreed they would be willing to have another telerobotic examination in the future.

CONCLUSION

The telerobotic ultrasound system assessed is feasible for performing prenatal ultrasound examinations. Telerobotic ultrasound systems may allow for the development of satellite ultrasound clinics in rural, remote, or low-volume communities, thereby increasing access to prenatal imaging.

CLINICAL RELEVANCE/APPLICATION

Telerobotic sonography may increase access to prenatal imaging for patients in rural, remote, or low-volume communities.

SSJ10-05 Magnetic Resonance Imaging Evaluation of Invasive Placentation: Accuracy and Impact on Delivery Management

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E351

Awards
Student Travel Stipend Award

Participants
Filippo Monelli, MD, Modena, Italy (*Presenter*) Nothing to Disclose
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PURPOSE

To assess accuracy and reproducibility of Magnetic Resonance Imaging (MRI) findings in the diagnosis of Invasive Placentation (IP) in high risk patients. To evaluate the impact of interventional radiological assistance (IRA) on delivery outcomes.

METHOD AND MATERIALS

Twenty-one patients (mean age 36.05 years) with risk factors for IP underwent 1.5T MR examination. Images were reviewed by two readers. Gold standard was histology in 11 and obstetrical diagnosis in 10 patients. Sensitivity and specificity of MRI findings were calculated and reproducibility was estimated with Cohen's K-test. Impact of eventual IRA was evaluated regarding multiple maternal-child factors during and after delivery.

RESULTS

IP was found in 13 patients (61.90%), placenta accreta/increta in 10 (47.62%) and percreta in 3 (14.29%). MRI had sensitivity of 100% and specificity of 87.5%. MRI findings with higher sensitivity were placental heterogeneity, uterine bulging, black intraplacental bands, myometrial interruption and thinning of the uterine-placental interface. Findings with higher specificity were uterine scarring, placental heterogeneity, myometrial interruption and tenting of the bladder. MRI inter-rater agreement was high (K=1). IRA was performed in 10 women among 13 with diagnosis of IP, with global positive impact on delivery's outcome. Factors with statistical significant difference ($p<0.05$) were: blood loss (1405 ml vs 3080 ml), days in surgical intensive care unit (1 vs 3), APGAR at first minute (6.11 vs 4) and overall days of hospitalization (12.00 vs 41.77).

CONCLUSION

MRI is an accurate and reproducible tool in prenatal diagnosis of IP and can be used to plan safe delivery in an appropriate setting with eventual IRA, that positively affects delivery's outcomes.

CLINICAL RELEVANCE/APPLICATION

MRI is extremely accurate in the diagnosis of invasive placentation and it has a strong indication in high risk patients allowing to plan delivery with eventual interventional radiological assistance.

SSJ10-06 The Ringed Placenta on Fetal MRI: 11 Cases Linked with Fetal Ventral Body Wall Defects

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E351

Awards
Student Travel Stipend Award

Participants
Jesus A. Ocana, PhD, Indianapolis, IN (*Presenter*) Nothing to Disclose
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PURPOSE

Fetal MRI is increasingly used in high-risk pregnancies not just for diagnosis and treatment planning, but also for prognostication of neonatal outcomes. Ventral Body Wall Defects (VBWD) of variable manifestation are well-recognized on fetal MR imaging and have been described in the literature. In more severe cases, outcomes can be highly variable, and counseling in these cases can be extremely challenging. We present here a pattern of abnormal placental MRI signal not previously described, which we found to correlate with extremely high mortality in patients born with VBWD. Specifically, we identified abnormal T1 hyperintense signal in the placenta in a multi-ringed pattern in several cases of fetal VBWD which correlated with extremely high mortality. We have termed this finding, the "ringed placenta."

METHOD AND MATERIALS

A local database of prenatal imaging studies was used to retrospectively review prenatal cases with MR imaging which demonstrated the characteristic appearance of ringed placenta in patients with VBWD. Electronic medical records were also used to follow up on the outcome of the patients identified as having these same areas of signal abnormality.

RESULTS

The "ringed placenta" appearance was identified in 11 fetal MRI studies, with the neonates later confirmed at birth to have VBWD. On pathology, these placentae were variably described as containing massive perivillous hemorrhage, intervillous thrombosis, villous edema, and diffuse chorionic villitis. Out of the 11 identified cases, only one neonate survived beyond 3 months of life.

CONCLUSION

This work presents cases of VBWD in the fetus, demonstrating the presence of T1 hyperintense ringed patterns in the placenta, which correlate with subsequent high perinatal mortality. Given the pathologic findings, this MRI appearance may be secondary to global placental ischemia with reperfusion hemorrhage. In evaluating VBWD patients, accurate prognostic information can be critical for appropriate parental counseling, and it may also affect the approach to perinatal management. Further studies will be necessary to better evaluate the prognostic accuracy of this MR imaging sign.

CLINICAL RELEVANCE/APPLICATION

This novel sign may enable improved planning and more accurate counseling for parents, many of whom face very high levels of uncertainty during the pre-natal management of complex fetal anomalies.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSJ11

Genitourinary (Imaging of Benign Gynecological Disease)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353B

GU MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Hilton M. Leao Filho, MD, Sao Paulo, Brazil (*Moderator*) Nothing to Disclose
Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSJ11-01 Structured vs Narrative Reporting of Pelvic MRI for Fibroids: Impact on Treatment Planning

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E353B

Awards
Student Travel Stipend Award

Participants
Andrea Franconeri, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate the usefulness of MRI reporting of uterine fibroids using a structured disease-specific template vs narrative reporting for planning fibroid treatment by gynecologists and interventional radiologists.

METHOD AND MATERIALS

This is a HIPAA-compliant, IRB-approved study with informed consent waived given its retrospective nature. In April 2016, a structured reporting template for fibroid MRI examinations was developed in collaboration between gynecologists, interventional radiologists and diagnostic MRI radiologists. Study population included 29 consecutive women who underwent myomectomy for uterine fibroids and a pelvic MRI prior to implementation of structured reporting; and 42 consecutive women with MRI for uterine fibroids after implementation of structured reporting. Subjective evaluation by gynecologists and radiologists and objective evaluation for the presence of 19 key features were performed to assess the clarity and usefulness of the reports for treatment planning. Statistical analysis was performed using the Student t test, Fisher exact test and Wilcoxon signed-rank test.

RESULTS

More key features were absent from the narrative reports 7.3±2.5 (range 3-12) than from structured reports 1.2±1.5 (range 1-7), ($p<0.0001$). Compared to narrative reports, gynecologists and radiologists deemed structured reports both more helpful for surgical planning (gynecologists: 8.5±1.2 vs. 5.7±2.2, ($p<0.0001$); radiologists: 9.6±0.6 vs. 6.0±2.9, ($p<0.0001$)) and easier to understand (gynecologists: 8.9±1.1 vs. 5.8±1.9, ($p<0.0001$); radiologists: 9.4±1.3 vs. 6.3±1.8, ($p<0.0001$)).

CONCLUSION

Structured fibroid MRI reports miss less key features essential for treatment planning than narrative reports. Gynecologists and radiologists described structured reports to be more helpful for treatment planning and easier to understand.

CLINICAL RELEVANCE/APPLICATION

Structured reports for uterine fibroid MRI are more helpful, easier to understand and miss less key features essential for procedural planning than narrative reports.

SSJ11-02 Efficacy of Vaginal and Rectal Distension Using Gel in MRI for Deep Pelvic Endometriosis

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E353B

Participants

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PURPOSE

To study MR performance without and with per vaginal (PV) and per rectal (PR) gel distension for the detection of posterior compartment deep pelvic endometriosis (DPE).

METHOD AND MATERIALS

IRB approval and informed consent were obtained for this prospective study.Female patients presenting with clinically suspected DPE to a single centre underwent MRI to map their disease. Multiplanar T2 and axial T1W images were acquired without and with PV and PR gel. Each patient went on to laparoscopy.8 expert readers from 6 countries, all blinded, recorded sites of disease on 2 datasets with a minimum of 10 days between the readings. Each dataset comprised a mixture of without and with gel studies. Findings were collated and compared with gold standard laparoscopic data. MR performance without and with PV/PR gel was evaluated by calculating sensitivity, specificity, positive and negative predictive values. Variability between readers was calculated using the Fleiss' kappa coefficient.

RESULTS

Posterior compartment disease was recorded in a total of 22 sites in 9 women (mean age 34.8 years) in whom complete imaging and surgical data were available. With 8 readers, this gave a total of 176 potential sites of disease to be detected across all reads. 107 of 176 locations were identified on MR without gel and 139 of 176 with gel distension. There was a significant improvement in sensitivity, PPV and NPV between MR images without and with PV/PR gel distension for all regions assessed (p=0.006, 0.029 and 0.002 respectively). There was no statistically significant difference in specificity between groups.Interobserver concordance was substantial with a Fleiss' kappa coefficient of 0.76 without and 0.74 with gel distension.

CONCLUSION

Vaginal and rectal distension with gel significantly improved the sensitivity of MR for the detection of DPE.

CLINICAL RELEVANCE/APPLICATION

The use of PV/PR distension in MRI for DPE remains controversial. This study, with 8 expert readers, showed a significant improvement in sensitivity, PPV and NPV following the administration of gel.

SSJ11-03 Accuracy of Non-Contrast CT in Characterizing Simple Cysts in Late Post-Menopausal Patients: Do We Really Need to Perform an Ultrasound in All Cases?

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E353B

Participants
Muhammad U. Aziz, MBBS, Seattle, WA (*Presenter*) Nothing to Disclose
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Cory Lewis, DO, North Oaks, MN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Contrast enhanced CT (CECT) is accurate at characterizing simple appearing cysts with benign features relative to US. We sought to determine the accuracy of non-contrast CT (NCCT) in characterizing adnexal lesions found in late postmenopausal (>55 years) women and whether a probably benign adnexal cyst >1 cm on NCCT needs further US evaluation in all cases as is the case with current ACR guidelines.

METHOD AND MATERIALS

We performed an IRB approved HIPAA compliant retrospective review of 101 patients with 110 ovarian lesions found on NCCT with an associated CECT (reference standard) within 180 days (median: 7 days, 72% within 30 days). NCCT and CECT images were reviewed by different readers, blinded to the images from the other modality and patients' clinical information. Readers characterized each lesion by presence/absence of complex features (e.g., solid component, mural nodules and septae) and then classified lesions as simple cystic, complex cystic, solid-cystic or solid. Lesion classifications and characteristics were compared between modalities using Bhapkar's or the sign test. Cohen's kappa was used to assess agreement between modalities.

RESULTS

The average age was 68 years ± 10 (SD). Of 110 lesions, 72 (65%) were simple cysts, 22 (20%) were complex cysts, 9 (8%) were

solid-cystic and 7 (6%) were solid on CECT compared with 49 (45%), 39 (35%), 13 (12%), and 9 (8%) for the same categories, respectively, on NCCT. There was overall moderate agreement in lesion classification (kappa: 0.56), though more cysts were simple-appearing on CECT than NCCT (65% vs. 45%, p<0.001). This was primarily due to the increased number of perceived mural nodules (1% vs. 13%, p=0.01) and septae (12% vs. 37%, p<0.001) seen on NCCT compared with CECT. Of 49 simple cysts by NCCT, 48 were found to be simple cysts on CECT (PPV = 98.0%, 95% CI: 87.8-99.9%). Of 61 non simple cystic lesions by NCCT, 37 were also found to be non-simple cystic lesions on CECT (NPV = 60.7%, 95% CI: 48.3-73.0%).

CONCLUSION

Our study confirms the high accuracy of non-contrast CT in characterization of simple cysts seen in late postmenopausal women. On the other hand, non-simple cystic lesions were not as accurately characterized.

CLINICAL RELEVANCE/APPLICATION

Non-contrast CT accurately characterizes simple cysts; so if incidentally detected, these may not need further imaging characterization. Non-simple cysts may still need further imaging workup.

SSJ11-04 DTI and Tractography Correlated With Symptoms and Site of Pelvic Endometriosis

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E353B

Participants
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PURPOSE

The aim of the present study was to evaluate the sacral nerve roots aspects by the means of DTI tractography in women with endometriosis and to analyze the correlation between DTI abnormalities, the presence and intensity of different pain symptoms, and the endometriotic lesions found at surgery.

METHOD AND MATERIALS

In 2 years time, we enrolled 66 women affected by endometriosis and scheduled for surgery; they were asked for the presence of dysmenorrhea, deep dyspareunia and/or chronic pelvic pain (CPP), intensity of pain was recorded on a Visual Analog Scale (VAS) score. MRI was performed on 3T Magnet,DTI sequences was acquired and a 3D reconstruction of S1, S2 and S3 was achieved . FA was calculated for every root as described. Univariate analysis was performed collecting also data from the following laparoscopy.

RESULTS

DTI of sacral roots revealed a regular and homogeneous appearance in 17 (25.8%) patients, while 44 (66.7%) women showed abnormalities in microstructure reconstructions, consisting mainly of fiber irregularities and disorganization combined with the loss of the simple unidirectional course. In 5 (7.6%) women the reconstruction of the sacral roots was not possible. Pathological DTI was significantly associated with the severity of dysmenorrhea and CPP , but no association with dyspareunia (Pv=0.398) or dyschezia (Pv=0.738) was found. Furthermore, a higher duration of pain was significantly associated with a pathological DTI. Adhesions in Douglas Pouch resulted significantly associated with pathological DTI (Pv=0.001), as well as DIE (Pv=0.001) and tubo-ovarian adhesions.

CONCLUSION

Pathological DTI of the sacral nerves is associated to the presence of CPP, but also it is related to the type and the site of endometriosis being obliteration of the cul-de-sac, tubo-ovarian adhesions and DIE responsible of DTI abnormalities. This new noninvasive method may help both clinicians and surgeons to select a better and more personalized therapeutic approach or select those patients who might benefit from alternative treatments, such as presacral neurectomy, anaesthetic nerve infiltration, neurostimulation or different types of pain killers that target neuropathic pain

CLINICAL RELEVANCE/APPLICATION

DTI alteratons may help to select an alternative therapeutic approach such as presacral neurectomy, anaesthetic nerve infiltration, neurostimulation or different types of pain killers that target neuropathic pain

SSJ11-05 Virtual Histerosapingography in Daily Practice in 14200 Cases

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E353B

Participants
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PURPOSE

To illustrate the typical findings of virtual hysterosalpingography(VHSG) by MDCT in daily practice and the differential diagnosis with

To illustrate the typical findings of virtual hysterosalpingography(VHSG) by MDCT in daily practice and the differential diagnosis with other pathologies in patients studied between 2006 and 2014

METHOD AND MATERIALS

We evaluated the V-HSG studies of 14200 patients derived from our institution. Studies were performed using 64,128 and 256 multislice CT scanners. Scanning parameters were: On 64-row CT: slice thickness of 0.9 mm 120 kV and 100-250 mAs, with an average duration of each scan of 3.6 seconds. On 128 and 256-slice CT: slice thickness of 0.6 mm and a reconstruction interval of 3 mm, 80 kV and 100-150 mAs, with an average duration of each scan of 1.3 seconds. A a dilution of low-osmolality iodinated contrast (10-20 ml) was instilled into the uterine cavity. Images were analyzed using multiplanar reconstructions, 3D and virtual endoscopy.The duration of the CT scan, the radiation exposure and the degree of discomfort of the patients were documented.

RESULTS

The scan time was 3.5 and 1.3 seconds using 64-slice or 128-256-slice CT scanners respectively. The mean radiation dose was 0.9 and 0.3 mSv using 64-slice or 128-256-slice CT scanners respectively for each scan. In the cervical region were identified parietal irregularities (22%), thickening of folds (8%), polyps (7%), diverticula (5%), stenosis (5%) and sinechiaes (1%). In the uterine cavity were visualized polyps (35%), submucosal myomas (7%) and adhesions (3%). In addition changes were observed in the wall of the uterus: myomas (15%), malformations (3.2%), adenomyosis (5%) and cesarean section (12%). Fallopian tubes showed hidrosalpinx in 5% cases ;unilateral (3.4%) and bilateral (1.6%). Patients reported no or mild discomfort in 85% of the cases.

CONCLUSION

The VHSG allowed a proper assessment of the internal genital organs, providing useful diagnostic information on infertility and other gynecological disorders. The technique is painless, well tolerated by patients with low doses of radiation. These advantages place this modality as a valid alternative algorithm study in patients with infertility

CLINICAL RELEVANCE/APPLICATION

Virtual hysterosalpingographyis an useful diagnostic tool to obtain information on infertility and other gynecological disorders.

SSJ11-06 Prospective Comparison of 3D FIESTA versus 2D SSFSE MRI in Evaluating Pelvic Floor Dysfunction Disease

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E353B

Participants
Yanbang Lian, Zhengzhou, China (*Presenter*) Nothing to Disclose
Zhiyang Zhou, PhD, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Wuteng Cao, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Dechao Liu, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Zhicheng He, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To compare fast imaging employing steady state acquisition (FIESTA) sequence with single shot fast spin echo (SSFSE) sequence in terms of acquisition time, image quality, artifacts, and lesion detection.

METHOD AND MATERIALS

Fifty-three patients (mean age, 49 years; range, 21-81 years) suspected pelvic floor dysfunction disease (PFDD) were enrolled in this study and underwent high resolution dynamic magnetic resonance defecography (MRD). The MR imaging protocol included static T2-wighted fast spin-echo sequence in three planes and a single sagittal dynamic sequence of FIESTA and SSFSE for rest, left and defecation phase. The acquisition time of dynamic sequence was calculated. The sagittal data sets of FIESTA were compared with SSFSE data sets with respect to image quality, artifacts, and lesion detection. Quantitative values of acquisition time and lesion detection and qualitative analyses of image quality and artifacts were analyzed by using a paired Student's t test and the Kappa test, respectively.

RESULTS

Mean acquisition time of FIESTA sequence (80-slice/53 seconds) was significantly shorter than that of SSFSE sequence (40-slice/57 seconds) ($p<0.05$). More pelvic organ prolapse (39/53 VS. 22/53) and rectocele (21/53 VS. 11/53) were detected with FIESTA than SSFSE ($p<0.05$). There was no significant difference between FEISTA and SSFSE in image quality and artifacts (kappa=0.905, $p>0.05$). Readers preferred the FIESTA sequence for showing more details.

CONCLUSION

For time savings and the versatility of showing greater degree of lesions without compromise of image quality, the near real-time continuous imaging with FIESTA sequence should be included in MRD protocols to better evaluate pelvic floor dysfunction disease.

CLINICAL RELEVANCE/APPLICATION

We recommend that FIESTA sequence should be included in MRD protocols to better assess pelvic floor dysfunction disease.

SSJ12

Health Service, Policy and Research (Patient Centered Care)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S104B

HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Marta E. Heilbrun, MD, Salt Lake City, UT (*Moderator*) Nothing to Disclose
Kathryn Lowry, MD, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ12-01 Implementing Direct Patient Result Delivery in Radiography

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S104B

Awards
Trainee Research Prize - Resident

Participants
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Brian D. Coley, MD, Cincinnati, OH (*Abstract Co-Author*) Royalties, Reed Elsevier
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Alan S. Brody, MD, Cincinnati, OH (*Abstract Co-Author*) Consultant, Vertex Pharmaceuticals Incorporated; Consultant, Novartis AG; Consultant, Boehringer Ingelheim GmbH

PURPOSE

A subset of radiography outpatients in a large pediatric academic medical center were uncertain and sometimes anxious about how to receive their results. Our aim was to develop a practical system to offer results to these patients directly from a radiologist on the same visit. Goals were to achieve a high degree of patient declared understanding of results and positive feedback of their face to face interaction with the radiologist.

METHOD AND MATERIALS

The service evolved through four phases. In phase 1 (408 days) technologists screened outpatients and included those nervous about, or simply requesting, their results. We excluded any non-outpatient or those who would otherwise get results the same day from another provider. Patients completed an anonymous feedback survey after result delivery. Technologists and radiologists completed weekly feedback surveys. Phase 2 (55 days) expanded inclusion to outpatients without scheduled follow up. Phase 3 (21 days) expanded inclusion to offer results to all radiography outpatients using a patient self-screening survey at check in. Phase 4 (21 days) simply removed the wait time notification (10-20 min) from the self-screening survey.

RESULTS

The phase 1 direct result delivery rate was 1 patient per month, possibly due to technologists not identifying all potential patients. Phase 2 direct results tripled to 3 per month. Phase 3 results again tripled to 9 per month, but notably 92% of screened patients opted to receive results through their primary physician. In phase 4, with the wait period notification removed, results were delivered at a rate of 30 per month. More than 97% of patients reported understanding the radiologist delivered results. Patient feedback comments were 92% positive, 3% neutral, and 5% left blank. More than 84% of radiologists agreed that they experienced a sense of satisfaction afterward.

CONCLUSION

Having radiologists discuss results with patients was feasible, positive for radiologists, and clearly valued by patients. The highest, but manageable response was achieved when patients screened themselves. Still, direct result delivery may fall short of increasing patient awareness of radiologists' role in their care due to limited demand.

CLINICAL RELEVANCE/APPLICATION

Implementation of a service delivering results from radiologist to patient is feasible even when utilizing patient self-screening methods, and is a strongly positive experience for patients and radiologists.

SSJ12-02 Point-of-Care Virtual Radiology Consultations in Primary Care: A New Model for Patient-Centered Care in Radiology

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S104B

Awards
Trainee Research Prize - Resident

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PURPOSE

The use of virtual visits for routine outpatient care delivery has been steadily increasing. Limited data are available on the role of such visits in radiology. The goal of this study is to assess the value of point-of-care virtual consultations in radiology, through the implementation of synchronous video-based virtual consultations whereby referring primary care physicians can consult with a radiologist virtually and review studies in real-time while seeing a patient.

METHOD AND MATERIALS

We conducted an IRB-approved feasibility study of video-based radiology consultations in an internal medicine primary care clinic at a quaternary academic medical center. The study included 3 primary care providers (PCP) and enrolled 40 patients. Inclusion criteria consisted of the following: age >18, English speaking, recent radiology exam at our institution, and patients indicating verbal consent. Patients completed a pre- and post-visit survey. PCPs completed a post-visit survey. Primary study endpoints included the effect on patient and provider satisfaction, effect on patient experience and understanding of medical condition, and impact on PCP's management decisions. Statistical significance was assessed using student's t-test and Fisher's exact test.

RESULTS

Both patients and primary care providers indicated high satisfaction with the virtual radiology consult experience on a Likert scale of 1 to 5 (92 and 96% respectively). 89% of the patients reported increased understanding of their disease and improved patient experience as a result of the radiologist virtual visits. PCPs indicated that the consult was helpful for their management decisions in 83% of the visits. Virtual visits increased patient interest in receiving their imaging results from radiologists; 56% indicated interest in the pre-visit survey versus 88% in the post-visit survey (p=0.03).

CONCLUSION

Initial experience with virtual radiology consults show high rates of patient and provider satisfaction and increasing demand for the availability of these visits.

CLINICAL RELEVANCE/APPLICATION

Virtual radiology consults have the potential to advance radiology's value in care delivery by providing more personalized radiology care and by promoting patient-centered practice models.

SSJ12-03 Incidental Findings in Whole-Body MR Imaging of a Population-based Cohort Study: Frequency, Management and Psychosocial Consequences

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S104B

Participants
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PURPOSE

Management of incidental findings (IF) in whole-body magnetic resonance (MR) imaging remains controversial but highly relevant. We aimed to assess the frequency, management and psychosocial consequences of IF reporting in a population-based cohort study.

METHOD AND MATERIALS

From a population-based sample, a set of 400 participants underwent 3T whole-body MR imaging using a comprehensive protocol, including cranial (FLAIR, T1, SWI TOF), thoracoabdominal (T1 DIXON, multi-echo) and cardiovascular sequences (cine imaging, T1 mapping, LGE). All images were reviewed by a board-certified radiologist for presence of relevant IF according to a recommended list of relevant and non-relevant IFs based on current literature. In case of deviation the finding was referred for interdisciplinary panel adjudication. A participants' survey was conducted prior and 6 months after the MR scan regarding personal expectations, psychosocial consequences and experiences with IF reporting.

RESULTS

A total of 116 IF were reported in 89 participants (22.3%), of which 27 cases were reviewed by the panel. Additionally, 22 cases (5.5%) were referred to the panel but classified as not relevant for reporting. Among the reported IF, "Unclear Liver Lesion" (n=13), "Silent Myocardial Infarction" (n=12) and "Complex Renal Cyst" (n=9) were most common. Pre-/post-scan survey data were available in 251 participants. More than half of the participants (57.4%) noted in the pre-scan survey that reporting IF in general would be "very important" for them, which decreased to 43.0% after the scan ($p<0.001$); this decrease did not differ whether the participant had an IF reported or not ($p=0.75$). A small portion (2.3%) reported that waiting for the IF reporting was "very burdening" or "burdening". Of participants with reported IF, 9.1% felt that the results were "very burdening" while in contrast 56.8% classified the results as "very helpful".

CONCLUSION

In this cohort, the prevalence of IF was high, and many findings were adjudicated by an interdisciplinary panel. For participants, reporting of potential IF was highly important and added only minor psychological burden.

CLINICAL RELEVANCE/APPLICATION

Assessment of IF in population-based imaging research is important to study participants but associated with substantial resources of the investigators. Thus, optimized, workflow-oriented tools. such as structured reporting or deep learning algorithms may prove beneficial in this setting.

SSJ12-04 Radiological Counselling: A New Approach to Radiologist-Patient Relationship

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S104B

Participants
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PURPOSE

Patients are more and more interested in improvements within medicine, curious about alternative methods of treatment and more conscious about their health. This leads the patients to look often for medical specialists to get information about the best diagnostic procedure.

RESULTS

The service started in September 2015 and the patients involved were 215. The need of radiological counselling was greater for complex imaging modalities, such as magnetic resonance imaging (48%) and computed tomography (31%) than, for example, X-rays (14%). The survey on the first 50 patients showed complete satisfaction of the meeting with the radiologist, with a score of 4,5/5. The 60% of the cases were under 60 years-old, which highlights the increased concern, within the younger generation, about their health. The majority of the patients answered that they preferred to receive the radiological report by a meeting with the radiologist: 50% if there are normal findings and 80% if pathological.

CONCLUSION

The Radiological Counselling is a useful service and can improve the relationship between the patient and the radiologist, who gains a new clinical role. The results are satisfying and will help the management to improve this service and to raise the patient's trust in the institution. In particular, the intention is to monitor patients after a pathological diagnosis, during their radiological follow-up and to research in which sub-specialty the service is more needed (neuroradiology, breast radiology, oncologic imaging, musculoskeletal radiology, thoracic radiology).

METHODS

To meet our patients' needs, the "Radiological Counselling" was introduced, a service which allows patients to have a meeting with the radiologist. This is useful for patients to learn the different and best imaging modalities, to have an explanation of what is written in the radiological report and to have recommendation about the best diagnostic process. Every radiologist reserved 2-3 hour a week for this service and the appointments were taken by the administrative office. The patients usually met the doctor who signed the report. The service outcome has been investigated by a survey on the first 50 patients that used radiological counseling: after the meeting with the radiologist, they answered a questionnaire about their age and sex, their satisfaction as well as the preferred method of communication in normal or pathological findings. In particular, It was asked if they preferred to receive the report: 1) at the reception of the radiology department (which is the method currently in use), 2)by the general practitioner,3) by a phone call from the radiologist 4) by a meeting with the radiologist or 5) by email or internet.

PDF UPLOAD

https://abstract.rsna.org/uploads/2017/17012739/17012739_aw31.pdf

SSJ12-05 Patient Expectations for Receiving Imaging Results: Implications for Patient Portal Embargo Period

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S104B

Participants
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PURPOSE

The electronic patient portal is used by patients to access their imaging results. The objective of this study is to determine patient expectations for receiving imaging results.

METHOD AND MATERIALS

A prospective HIPAA-compliant multicenter outpatient survey using questions administered by a trained interviewer. The survey was reviewed by patient advocates with experience in survey design and underwent patient precognitive testing for readability. Over a four month period, outpatients receiving imaging tests were asked to participate in a survey regarding patient expectations for receiving imaging results. Descriptive statistics were calculated.

RESULTS

The response (93% [202/218]) and completion (100% [202/202]) rates were excellent. Patient expected median imaging result turn around in different scenarios are the following: 3 days (IQR 5) after screening, 2 days (IQR 3) after CXR for chest pain, 1 day (IQR 2) after CXR for pneumonia, 2 days (IQR 2) after MRI/CT for back pain, 1 day (IQR 2) after MRI/CT for brain tumor, and 1 days (IQR 3) after CT for cancer treatment. If patients do not have their imaging results yet, they will call their provider to inquire about results by the following median days in different scenarios: 5 days (IQR 4) after screening, 2 days (IQR 4) after CXR for chest pain, 1 day (IQR 2.75) after CXR for pneumonia, 2.5 days (IQR 3) after MRI/CT for back pain, 1 day (IQR 3) after MRI/CT for brain tumor, and 2 days (IQR 3) after CT for cancer treatment. Waiting on imaging results causes a negative effect on patient state of mind in 20% [38/188] and emotional change in 45% [91/202] with the majority (85% [77/91]) of emotional distress being anxiety (minimal 28%, mild 45%, moderate 22%, severe 4%, extreme 1%).

CONCLUSION

Patients expect their imaging results by 3 days and will call outpatient clinics by 5 days.

CLINICAL RELEVANCE/APPLICATION

The results support delivering imaging results within 3-5 days. These data can be used to inform institutional policy regarding automated imaging result release.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ella A. Kazerooni, MD - 2014 Honored Educator

SSJ12-06 Radiologist Experiences with Direct Patient Interactions

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S104B

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PURPOSE

To evaluate radiologists' attitudes and experiences with direct patient contact and how interactions with patients affect the workflow.

METHOD AND MATERIALS

This prospective survey of staff and trainee radiologists (n=128) at tertiary academic institution was performed with approval of our institutional review board. A multiple choice questionnaire with optional free text comments was distributed via departmental email between June 2016 and July 2016. Participation in the survey was voluntary and anonymous and responses. Statistical analysis of categorical responses was performed with the chi-squared test with statistical significance defined as $p<0.05$.

RESULTS

Response rate was 73.4%, (94/128), with 54.3% (51/94) of the respondents being staff radiologists and 45.7% (43/94) trainee radiologists. Majority of the respondents , 78.7% (74/94), found interactions with patients to be satisfying experiences. 51/94 (54.3%) of radiologists desired more opportunities for patient interaction. Similar percentage of staff and trainees desired more patient interaction (56.9% (29/51) vs. 51.2% (22/43), p=0.58). Staff radiologists who specialized in vascular and interventional radiology and breast imaging were significantly more likely to want more patient interaction compared to those who specialized in other areas (77.8% (14/18) vs 45.5% (15/33), p=0.03). Only 4.2% (4/94) of radiologists found patient interactions to be detrimental to normal workflow. Most interactions between radiologists and patients, 80.9% (76/94), took less than 15 minutes. Only 14/94 (14.9%) of radiologists indicated they had ever refused to communicate directly with a patient when the patient requested discussion with radiologist. Majority of radiologists 62/94 (66.0%) were comfortable discussing potentially distressing and ominous results directly with their patients.

CONCLUSION

A majority of radiologists are open for more opportunities for interactions with patients and find them satisfying experience. Meeting a patient takes usually takes less than 15 minutes and is not felt to significantly affect the workflow.

CLINICAL RELEVANCE/APPLICATION

The should be opportunities for more direct patient-radiologist contact in clinical practice, as these interactions are rarely detrimental to the radiologists' workflow, while majority of radiologists find these interactions to be a satisfying experience.

SSJ13

Informatics (3D Printing)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N230B

IN

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSJ13-01 Low-Cost Fabrication of Interventional Radiologic Training Models using Fused Filament Fabrication and Silicone Molding

Tuesday, Nov. 28 3:00PM - 3:10PM Room: N230B

Participants
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PURPOSE

Procedural training is a vital element to become confident in interventional procedures yet training models are expensive, not universally available and not patient-specific. We demonstrate an easy, cost-effective and reproducible approach to create vascular and tissue models with a combination of 3d printed scaffolding and silicone molding.

METHOD AND MATERIALS

With the use of open source 3D-Modelling software the model of a generic stenosis was developed with defined connections for an angiography simulator. A negative form of the model was derived and printed on an consumer fused filament fabrication 3d printer. The form was then casted using a clear yet flexible silicone. After curing the form was scanned in a CT scanner and registered on the initial model to ensure production precision. A second model was developed to train venous access management for technologists and students using a CT scan of a forearm that was segmented for bone and soft tissue. Intravenous lines were used to simulate veins with a diameter of 4 and 2 mm as well as to ensure easy compatibility to iv-systems of the hospital. After curing the lines were removed and the proximal entry was connected to an infusion to provide simple gravity-based vascular flow.

RESULTS

Reproducibility of stenosis model to the original file was excellent. The model is to be used as a training modality for interventional radiology and vascular surgery courses and was received with great interest. Material properties of the chosen silicone are reported to be vascular like. The second model is being used in the education for technologists yet the material characteristics of the soft tissue need to be improved.

CONCLUSION

A combination of segmentation, modelling and 3d printed scaffolding together with silicone casting proves to be a great way to develop easy, cost-effective and reproducible models. This approach can be used to create generic training models for the education of technologists and interventional radiologisty residents as well as patient-specific models for training and planning before high-risk interventions.

CLINICAL RELEVANCE/APPLICATION

The use of 3d-printed scaffolding and silicone molding allows to create cost-effective models for procedural training that help technologists and residents to become more confident in interventional procedures.

SSJ13-02 Patient-Specific Orbital Implant Shaping Guide for Orbital Wall Fracture Repair Using 3D Printing

Tuesday, Nov. 28 3:10PM - 3:20PM Room: N230B

Participants
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CONCLUSION

The implant shaping guide using 3D printing can be used for shaping the surgical implant precisely in orbital wall fracture repair. This exact mapping of shape and surface of defect site into a surgical implant would let surgeons secure the defect margin more confidently, and promise shorter operation time and convenience as well.

Background

The commercialized orbital implant is usually used to reconstruct bone fracture region in patients with orbital wall fracture. In the existing surgical method, surgeons guess the bone fracture region visually during surgery and shape the planar orbital implant manually before inserting it into the fracture site. It is very hard to match the implant to the 3D shape and size of the defect by use of the conventional 2D cutting method. Any discordance would lead to postoperative complications such as enophthalmos and diplopia.

Evaluation

From CT images, the fracture site of volume of interest was segmented in Fig. 1-A. The implant surface was created by an expert so that the damaged part could be covered. (Fig. 1-B) The 3D model was generated from the segmented 2D mask and fitting of orbital bone and implant were checked, which was converted into a STL format in Fig. 2. Planar orbital implants were regenerated as the created surfaces, and the zig molder, press was generated and used for shaping of the implant. (Fig. 3) The guide was washed and sterilized with isopropanol or EO gas for clinical use after remove supporter, and transported to the operating room. For surgery, the surface of zig molder was coated with surgical film not to direct contact with molder and patient. During the operation, the Implant plate was compressed using a sterilized molding model, and inserted into the fracture site.

Discussion

Seven eyes of 6 patients underwent orbital wall reconstruction using 3-dimensional printing between November 2016 and December 2016. Follow-up time ranged from 3 to 4. There were 4 men and 2 women. There were no complications such as loss of vision, infection, displacement or exposure of the implant. There was no significant difference in the orbital volume between the undamaged orbit and reconstructed orbit (21.84 ± 1.67 vs 21.83 ± 1.72 cm3, P = 0.89).

SSJ13-03 Utilizing the Power of the EMR, RIS, and VNA for 3D Printing Lab

Tuesday, Nov. 28 3:20PM - 3:30PM Room: N230B

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CONCLUSION

Building a 3D workflow in an existing EMR has potential benefits to facilitate the 3D service delivery process. It allows 3D printing to rank amongst other modalities important for patient care by living where all other clinical care orders reside. It also allows 3D Lab staff to document the process through quick communication with clinicians. The easier use and availability of 3D printed models will ultimately provide better patient care.

Background

In recent years' 3D printing, has shown exponential growth in clinical medicine, research, and education (Carlos et al.). Imaging departments are at the center of 3D printing service delivery, efforts of establishing a 3D printing lab, and making it a unique contribution towards patient care (Kent Thielen et al.). Building a fully electronic medical record (EMR) integrated workflow to deliver 3D services offers unique advantages for clinicians.

Evaluation

We have successfully tested the electronic process by generating 3D orders and delivering the printed models such as of the heart, skull, face, and ear.

Discussion

To facilitate clinicians and 3D printing lab staff, we developed an automatic workflow in our EMR and radiology information system (RIS). Clinicians use our Cerner EMR to order 3D printing services by selecting the available 3D printing orders for each modality i.e. MR, CT, and US. The order also allows them to add their requirements by filling out relevant Order entry fields (OEFs). 3D printing orders populate the RIS worklist for 3D lab staff to start, complete, and document the service process. Consultation with ordering clinicians and radiologists is also vital in 3D printing process, so we developed a message template for the communication between lab staff and clinicians, which also has the capability to attach 3D model PDFs. 3D Lab staff upload the models to our Vendor Neutral Archive (VNA) before completing, storing the models in the patient's record.

SSJ13-04 A 'Super-resolution' Algorithm for Generating Optimal 3D Printed Models From Multiple Sub-Optimal Non-Isotropic Resolution Clinical Images

Tuesday, Nov. 28 3:30PM - 3:40PM Room: N230B

Participants
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CONCLUSION

A method has been developed to "super-resolve" anatomy imaged in multiple independent, lower resolution CT/MR data sets for more accurate 3D printing than possible using the underlying images individually

Background

Clinical protocols often do not acquire high resolution data (<1-1.5mm slice thickness) to successfully 3D print anatomy. When the need for 3D-printing is known ahead of imaging, protocols can be adjusted to obtain appropriate data. However, this is not always possible due to signal-to-noise ratio vs imaging time in MR, and radiation dose in CT. For example, for pelvis CT in a large teaching hospital where ALARA principles are applied, 3mm thick slices in all 3 planes (axial [ax], sagittal [sag] and coronal [cor]) are obtained, but reconstructing 1mm slices for printing yields images too noisy to segment. On some CT equipment, sag/cor reconstructions are produced directly from the sinogram, rather than reformatting of axial images. In those cases, image voxels reconstructed at each plane contain intrinsically different information. Similarly, MR images at different planes contain information from intrinsically different spins excited for each slice

Evaluation

We developed a method to combine data from independent multi-planar images into a single "super-resolution" 3D image set, using the highest resolution for each axis amongst the available image data sets, that can be more easily and accurately segmented. The method uses the voxel size and location of all low-resolution images (with or without registration as necessary) to produce a single higher-resolution voxel grid whose image intensities satisfy the lower-resolution images as mathematical constraints. The method was used on CT images of a pelvis with prior periacetubular osteotomy and fracture. Bone was automatically segmented from each ax/sag/cor 3mm images interpolated to 0.5mm, and from super-resolved images reconstructed using the new method at a 0.5 mm grid

Discussion

The method enabled accurately segmenting anatomy demonstrating a superior pubic ramus fracture and prior hardware that none of the individual (ax/sag/cor) clinical CT images allowed despite being interpolated to a higher resolution grid

SSJ13-05 Creation of Low-Cost Multi-colored Clear 3D Printed Models

Tuesday, Nov. 28 3:40PM - 3:50PM Room: N230B

Participants
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CONCLUSION

With minimal post-processing, it is possible to create low-cost, clear 3D printed models with colored components using consumer grade Stereolithography printers. These models are ideal for percutaneous and endovascular pre-procedure planning.

Background

While there has been rapid expansion of low-cost solutions for creation of opaque 3D printed models in Radiology, the creation of clear models with colored internal components has been limited. PolyJet printers offer the ability to create clear models with multi-color components, but printer costs are >$150,000 and material costs are often prohibitive. Here, we present a technique to create low-cost clear models with colored components using a consumer-grade stereolithography printer at <5% of the cost of traditional techniques.

Evaluation

Clear visceral, bony and vascular 3D printed models with colored internal components are valuable for visualizing internal structures relative to more superficial anatomy. Examples include renal tumors and bony lesions. PolyJet printers are directly able to create multi-color models with clear components; however, the printers and their materials cost hundreds of thousands and hundreds of dollars respectively. Desktop stereolithography printers cost <$5000 and allow creation of clear 3D printed models at low cost. However, these printers can only print with one material at a time. Our technique centers on creating models with internal structures modeled as hollow cavities. These cavities are then filled with paint. As an example, when creating clear renal models with colored components depicting the collecting system and tumor (figure), traditional polyjet techniques result in model costs of $1000. Using our techniques, models cost an average of $29.01 (SD: $6.79, n = 5).

Discussion

Here, we present a technique for creating multi-color models using low cost SLA 3D printers with relatively easy post-processing. Our experiences show that creation of low-cost, high-quality clear models with colored components is feasible and can be done at a tiny fraction of the cost of traditional techniques. This results in the removal of a primary barrier for implementation of 3D printing in hospitals.

SSJ13-06 Characterization of 3D Printing Materials: Hounsfield Unit Energy Dependence and Comparison to Commercially-Available Tissue Equivalent Materials

Tuesday, Nov. 28 3:50PM - 4:00PM Room: N230B

Participants
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PURPOSE

To compare Hounsfield Units (HU) of commonly used 3D-printing materials (3DMs) to tissue-equivalent materials (TEMs) from commercially-available phantoms. Further, to examine the energy dependence of 3DMs and estimate visibility of 3D-printed implants or instruments in computed tomography (CT).

METHOD AND MATERIALS

A Stratasys Object 350 Connex3 printer produced 1"x 1"x 1" cubes of six common materials. Stratasys materials were chosen because it has the largest commercial install base in the world. Silicone used to fill 3D-printed molds was also characterized. TEMs from the American College of Radiology (ACR) Image Quality Phantom and the RMI 641A phantom were characterized for comparison. All materials were CT scanned at 80, 100, 120, and 140 kV on a Philips Ingenuity 128 and GE VCT 64. 3DM: 1. RGD-CW-004-DM (mix of VeroWhite+ & VeroCyan), 2. FLX9870-DM (mix of TangoBlack+ & VeroWhite+), 3. RGD835 (VeroWhite+), 4. RGD8525-DM (mix of TangoBlack+ & VeroWhite+), 5. RGD843 (VeroCyan), and 6. FLX980 (TangoBlack+). Silicone: Smooth-on platinum cure silicone rubber compound

RESULTS

All 3D-printed materials were between 40HU and 140HU and demonstrated a slightly increasing HU trend with tube voltage. ACR acrylic also demonstrated a slightly increasing HU trend with tube voltage. Four of the six 3DMs were equivalent to ACR acrylic. Material 6 (TangoBlack+) had an HU between water surrogates and ACR acrylic. Material 2, a mixture of TangoBlack+ and VeroWhite+, had an HU higher than TangoBlack+ alone demonstrating how mixtures could be used to produce low contrast structures if desired. Silicone had a strong non-linear decreasing dependence with tube voltage. Unfortunately, none of the 3DMs investigated were similar to water, fat, or bone. Scanner make/model did not significantly impact HU of the investigated materials ($p = 0.21$).

CONCLUSION

Materials typically used in 3D-printing have a slight energy dependence and their HU is between that of soft-tissue and muscle. 3DMs investigated here would be suitable to model organs and muscle in CT phantoms; however, printed implants or instruments using these 3DMs may not be visible in muscle or organs due to their similar HU and thus low contrast.

CLINICAL RELEVANCE/APPLICATION

The 3D-printed materials investigated here are suitable for organ and muscle modeling, but implants and instruments made from these materials could be invisible on CT scans due to the HU similarity to organ and muscle.

SSJ14

Molecular Imaging (Renal, Hepatic, Cardiovascular)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S504CD

MI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Jeff L. Zhang, PhD, Salt Lake Cty, UT (*Moderator*) Nothing to Disclose
Chun Yuan, PhD, Seattle, WA (*Moderator*) Research Grant, Koninklijke Philips NV; Consultant, BGI; ;

Sub-Events

SSJ14-01 Multimodal Imaging of BAT Activity in Type I and Type II Diabetes Mouse Models Using 7T MRI and Intravital Microscopy

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S504CD

Participants
Caroline Jung, Hamburg, Germany (*Presenter*) Nothing to Disclose
Markus Heine, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
Nils Mangels, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine the metabolic activity of brown adipose tissue (BAT) in type I and type II diabetes mouse models using superparamagnetic iron oxide nanoparticles (SPIO - for MRI) or quantum dots (QD - for intravital microscopy (IVM)) embedded into triglyceride-rich lipoproteins (TRL).

METHOD AND MATERIALS

C57BL/6J wild-type were either treated with Alloxan which is selectively toxic to pancreatic beta cells (100µl iv; Alloxan monohydrate, Abcam) to induce type I diabetes or received a 35% Lard-based high fat diet over 16 weeks to induce type II diabetes. BAT activity was stimulated by treatment with the ß3 receptor agonist CL316,243. All mice were starved for 4 hours before imaging. MRI at 7T ClinScan (Bruker) was performed before and 20 minutes after iv injection of TRL-SPIOs using a T2*w Multiecho-GRE sequence (TR/TEfirst 400/2ms, ETL 12, ES 1ms, FA 25°). In addition to the MRI set up, IVM analysis was performed for real time imaging of TRL-QD uptake into BAT. In order to quantify TRL clearance, the fate of radioactively labelled TRLs were analysed under the same experimental conditions.

RESULTS

While control mice showed a significant signal drop after CL treatment, no significant signal difference in BAT before and after the injection of TRL-SPIO was detectable neither for type I nor for type II diabetes mouse model. Analogy real time IVM analyses showed a clear reduction of TRL-QD in case of diabetes disease mouse models. MRI and IVM results were confirmed by quantitative metabolic studies using radioactive lipid tracers. In both setups diabetes type I and type II lead to a reduction of TRL uptake into BAT.

CONCLUSION

ß3-receptor activation via CL with following acute insulin release lead to BAT activation, which can be visualised in vivo by MRI using TRL-SPIO. However, in case of diabetic disease, the uptake of TRL into BAT is diminished, indicating a loss of BAT activity in this case. Thus, MRI can visualize physiological lipid processing in the vascular endothelium of activated BAT.

CLINICAL RELEVANCE/APPLICATION

MRI in combination with nanoparticle-labelled lipoproteins can be used to noninvasively monitor the molecular pathway of insulin-dependent lipoprotein metabolism.

SSJ14-02 Evaluation of Early Renal Injury Development in Diabetic Rats by BOLD-MRI

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S504CD

Participants
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PURPOSE

To observe changes in renal oxygenation levels by BOLD-MRI, and sought to evaluate the usefulness of BOLD-MRI in development of early diabetic renal injury.

METHOD AND MATERIALS

80 male SD rats with left uninephrectomy were randomly divided into normal control (NC) group and diabetes mellitus (DMN) group. Streptozotocin (65 mg/kg) was intraperitoneally injected in DMN group, and the NC group given with saline. BOLD-MRI scans were performed for the two groups at different time points ,NC group as baseline and DMN group at 3, 7, 14 ,21, 28, 35, 42, 49, 56, 63 and 70 days following streptozotocin injection. Renal cortical and medullary R2*(CR2*, MR2*) signals were measured and R2* ratio of medulla and cortex (MCR) was calculated. Urinary protein excretion(UAE) and histopathological examination were evaluted at different time points.

RESULTS

CR2* and MR2* values of diabetic rats were significantly higher than control group rats at different time points after induction of diabetes ($P < 0.01$). Those R2* values raised gradually and reached the peak at day 35 (CR2*=33.95±0.34 s-1,MR2*=43.79±1.46 s-1), then dropped gradually until day 70 (CR2*=33.17±0.69 s-1, MR2*=41.61±0.95 s-1) , but still significantly higher than the control group (CR2*=28.41±0.56 s-1,MR2*=31.77±0.87 s-1) ($P < 0.01$). MCR in DM group rose gradually from 1.12 to 1.32 at day 42, and then decreased to 1.25 at day 70. UAE of DMN group increased gradually, it was significantly higher than that of NC group since day 7($P < 0.01$).The GSI was higher in DMN group compared to NC. Mesangial volume density (Vvmes) and the capillary surface density (Svcap) was increased in the DMN group when compared to NC .

CONCLUSION

BOLD-MRI can non-invasively evaluate the renal hypoxia in diabetes and detect diabetic renal injury earlier than UAE. The dynamic changes MCR like a downward parabola in our study diabetic would be adopted to reflect the dynamic changes from stage II to stage of diabetic renal injury proved by Mesangial proliferation and nodular sclerosisis appearing pathologically.

CLINICAL RELEVANCE/APPLICATION

BOLD-MRI can non-invasively evaluate the renal injury early and dynamically

SSJ14-03 VLA-4 Targeted Liposomes for Noninvasive Visualization of Vulnerable Plaques in ApoE(-/-) Mice by MRI

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S504CD

Participants
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PURPOSE

Currently, there is no approved method for diagnosing cardiovascular complications of atherosclerosis which delineates the cellular and molecular components that predict plaque stability (1). Activated monocytes/macrophages and T-lymphocytes constitute about half the cellular makeup of vulnerable plaques and contribute to weakening and eventual rupture (2). We report herein, a nanoparticle targeted to VLA-4 (a surface receptor on leucocytes), that labels and enables noninvasive visualization of vulnerable plaques in ApoE(-/-) mice by MRI at 1 Tesla.

METHOD AND MATERIALS

A lipid mixture containing lipid-PEG-THI567 conjugate, DSPE-PEG-DOTA-Gd complex, and Rhodamine DHPE was subjected to a standard liposome formulation protocol to achieve targeted particles with size ~170±10nm. A control untargeted formulation was also prepared. Flow cytometry was used to evaluate particle binding and receptor specificity in vitro, and leukocyte cell subset binding distribution in vivo. MR imaging in ApoE(-/-) mice mice (protocol approved by the IACUC, N=7 for controls, N=9 for the test group), was performed on a 1.0 Tesla MRI scanner. Images were acquired pre-, immediately after, and 72-96 hours post contrast injection. Following the last scan, animals were sacrificed, and the aortic arch, carotids and descending aorta were frozen for histology.

RESULTS

VLA-4 targeted particles bind activated monocytes and T-lymphocytes both in vitro and in vivo with picomolar binding constants. In delayed phase imaging, animals injected with the targeted liposomes showed enhanced regions in the aortic arch or the descending aorta, with 4-fold greater mean signal than the animals injected with the untargeted agent. Histochemical analysis of tissue sections from the treated animals showed co-localization of the targeted particles and immune cells within the plaques as shown in Figure 1.

CONCLUSION

Liposomal nanoparticles bearing a T1 contrast agent, targeted to monocytes/macrophages and T-lymphocytes allows for noninvasive visualization of vulnerable plaques in ApoE(-/-) mice by MRI at 1T.

CLINICAL RELEVANCE/APPLICATION

A sensitive, specific method to identify vulnerable plaques before they rupture and could dramatically change the therapeutic course for patients with atherosclerotic lesions.

SSJ14-04 Identification of Metabolic Regulation Mechanism Involved in Diabetes Comorbid Depression by Ex Vivo High Resolution 1H-NMR Spectroscopy

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S504CD

Participants
Wen Xu, Hangzhou, China (*Presenter*) Nothing to Disclose

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PURPOSE

To investigate the mechanism and find related biomarkers of diabetes comorbid depression, 1H nuclear magnetic resonance (1H NMR)-based metabonomics were applied to study the metabolic changes in the prefrontal cortex(PFC), hippocampus(HI) and hypothalamus(HY) of the comorbidity rats.

METHOD AND MATERIALS

Male wistar rats were divided into two groups: control group(group Con) and diabetes combined depression group(group DD). Rats of group DD were injected intraperitoneally with STZ, the control rats received sham injections of citrate buffer alone. Group DD were then exposed to chronic unpredictable mild stress(CUMS) for 28 days. All rats were submitted to the open-filed and Morris water maze tests immediately after the CUMS procedure. After brain tissue collection, a part of tissue were used for measuring the expression of glial fibrillary acidic protein(GFAP), glutamine synthetase(GS), glutaminase(GLS), glutamate decarboxylase(GAD) in PFC, HI and HY by immunohistochemistry. The rest of tissue underwent NMRS to find out metabolic changes in these cerebral regions.

RESULTS

Group DD showed high blood glucose level (>33.3mol/L), declined body weight (P<0.01), and exhibited other typical signs of diabetes. In the open-field test, group DD showed reduced total traveling distance and locomotor activity (P<0.05). Throughout the probe trial of Morris water maze test, group DD performed less times of crossing the former platform area (P<0.05). The mean optical density(MOD) of GFAP and GLS in aforementioned regions of group DD were elevated, while declined MOD of GS in these regions and GAD in the PFC increased (P<0.05). The level of Lac increased in all three regions of group DD compared with group Con. Decreased Glu, Gln, NAA, Cre and Cho, but increased Tau were obtained in PFC and HI. Besides, declined levels of Asp and Gly were observed in PFC, decreased Ala but increased m-Ins were presented in HI. In HY, concentrations of GABA, NAA, Ala, Glu, Gln, Cho, Gly, Asp all decreased.

CONCLUSION

Alterations in energy metabolism and amino acid neurotransmitters metabolism might be associated with the pathogenesis of diabetes comorbid depression, and disordered Gln-Glu-GABA cycle plays a crucial role in neuron injury of the comorbidity.

CLINICAL RELEVANCE/APPLICATION

The overall findings may contribute to the understanding of the underlying mechanism and provide some potential targets for treatments to ameliorate the effects of the comorbidity.

SSJ14-05 Hyperpolarized [13C1] Pyruvate Metabolism in Precision-Cut Mouse Liver Slices

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S504CD

Participants
Naama Lev-Cohain, MD, Jerusalem, Israel (*Presenter*) Nothing to Disclose
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Rachel Katz-Brull, PhD, Jerusalem, Israel (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

[13C1]Pyruvate metabolites in a hyperpolarized state have been visualized in whole rodent liver in vivo and ex-vivo. However, this approach does not permit the necessary radiology-histopathology needed to adequately evaluate the technique as a marker of the relevant biologic process. Precision cut liver slices have the potential to breach this obstacle. We aimed to validate the use of precision cut liver slices for hyperpolarized metabolic investigation in a mouse model. Following validation of the slices viability by 31P NMR spectroscopy and detection of ATP signals, hyperpolarized [13C1]pyruvate was administered to the slices and its metabolism was followed.

METHOD AND MATERIALS

Fresh normal livers were harvested from five mice. The livers were sliced with a microtome-tissue slicer to 500 µm thickness slices and placed in an ice-cold recovery medium. The slices were then placed in an NMR spectrometer (5.8 T, RS2D, France) and perfused continuously with oxygenated growth media at 37 °C. 31P spectra were acquired to evaluate the presence of ATP. After

ATP production was seen, hyperpolarized [13C1]pyruvate was flushed into the NMR tube in the spectrometer, into the liver. Consecutive 13C NMR spectra were acquired immediatly after the injection. Spectral analysis was performed using MNova (Mestrelab Research, Santiago de Compostela, Spain).

RESULTS

The 31P spectra collected from each liver showed the characteristic signals of ATP, confirming the viability of the tissues slices in the spectrometer. After each of the [13C1]pyruvate injections, both [13C1]lactate and [13C1]alanine signals were detected within 20 sec, for a duration of 1.5 min.

CONCLUSION

We were able to maintain and show the viability of precision-cut mouse liver slices in an NMR spectrometer as well as record hyperpolarized [13C1]pyruvate metabolism for the first time. This suggests that it can be used for ex-vivo evaluation of liver metabolism. This strategy is translational to the study of human liver metabolism ex-vivo as very small amounts of tissue are required. This approach is likely to lead to more accurate assessment of intracellular processes in a personalized manner.

CLINICAL RELEVANCE/APPLICATION

The validation of precision-cut mouse liver slices has great impact on the ability to increase evaluation accuracy and metabolites quantification. This new translational finding can improve evaluation of numerous biological processes in liver diseases.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Jacob Sosna, MD - 2012 Honored Educator

SSJ14-06 Quantitative Optoacoustic Imaging Detects Changes in Renal Ischemia: Potential New Horizons in Renal Transplant Imaging

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S504CD

Awards
Student Travel Stipend Award

Participants
Oshaani Abeyakoon, MBBS, FRCR, Cambridge, United Kingdom (*Presenter*) Nothing to Disclose
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Iosif A. Mendichovszky, MD, PhD, Cambridge, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Sarah Bohndiek, MSc,PhD, Cambridge, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Fiona J. Gilbert, MD, Cambridge, United Kingdom (*Abstract Co-Author*) Research Grant, Hologic, Inc; Research Grant, General Electric Company; Research Grant, GlaxoSmithKline plc

PURPOSE

Optoacoustic imaging (OPUS), a novel technique based on measuring the differential absorption characteristics of oxy/deoxyhemoglobin in perfused tissues, has the potential to assess changes in tissue oxygenation during renal cortical ischemia. The aim of our proof of principle study was to explore the potential of optoacoustic imaging to detect quantitative changes in oxygen saturation in the renal cortex of revascularized porcine kidneys under ex-vivo normothermic perfusion conditions.

METHOD AND MATERIALS

Four porcine kidneys harvested by the animal licence holder on two separate occasions were evaluated. The harvested organs were perfused with a fully oxygenated (100%) warm red cell solution at a constant flow rate of 85 mls/min. An OxyLite probe was placed within the renal cortex under imaging guidance, distal to the external optoacoutic probe but within the same pyramid, approximately 1 cm apart (to avoid interference between the tip of the probe and the optoacoustic scanner). Real time measurements correlating the detected OPUS signal with the measurements from the OxyLite probe were made while clamping the renal artery intermittently until the kidney infarcted.

RESULTS

Kidneys 1 and 4 infarcted when connected to EVNP before results were obtained. Kidneys 2 and 3 showed a good temporal correlation between the indirect OPUS-derived oxygen saturation measurements and the OxyLite probe. The results are summarised in the figure uploaded.

CONCLUSION

Our preliminary results indicate that renal cortical ischemia can be assessed with a clinical optoacoustic system and OPUS measurements correlate with invasive OxyLite measurements in revascularised porcine kidneys under ex-vivo normothermic perfusion conditions. This first, but important step, opens the possibility of further evaluating the utility of this technique to assess transplant viability and develop it further as a method to detect renal ischemia.

CLINICAL RELEVANCE/APPLICATION

The ability to non-invasively quantify renal cortical ischemia is an important advance in treatment planning and assessing the viability of a transplant kidney.

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McCormick Place, Chicago
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SSJ15

Musculoskeletal (Muscle and Nerve)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E450B

MR MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Darryl B. Sneag, MD, Plainview, NY (*Moderator*) Institutional research agreement, General Electric Company
Soterios Gyftopoulos, MD,MSc, New York, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSJ15-01 Multi-Parametric MRI Characterization of Changes in Skeletal Muscles with Aging

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E450B

Participants
Min A Yoon, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate age-related characteristics of thigh muscles by applying multi-parametric quantitative MRI and to investigate relationships between age and the parameters.

METHOD AND MATERIALS

Ninety-five healthy subjects (47 men, 48 women; median, 47 years; IQR, 39-58 years) with normal body mass index (18.5-24.9) were included for this prospective study. No subject had muscle disorder, diabetes, history of operation or trauma in the thigh region or was on medication. Age groups were as follows: 30-39 years (n=25), 40-49 years (n=25), 50-59 years (n=25), 60-69 years (n=20). Multi-parametric (intravoxel incoherent motion (IVIM) diffusion-weighted imaging (DWI), diffusion tensor imaging (DTI), multi-echo Dixon imaging, and dynamic contrast-enhanced (DCE)) MRI was acquired at 3.0 T. Parametric maps were evaluated by two radiologists independently in the following muscles: (1) anterior compartment: rectus femoris, vastus lateralis, medialis and intermedius; (2) medial: adductor longus and magnus; (3) posterior: biceps femoris, semitendinosus and semimembranosus. Significance of differences in multiple parameters in three thigh compartments between four age groups was determined by one-way analysis of variance (ANOVA) with post hoc Tuckey. Strength of relationships between multiple parameters and age was evaluated using Pearson correlation analysis. Interrater reliability was also assessed.

RESULTS

Significant differences between different age groups were appreciated for ADC, true diffusion (D), fractional anisotropy and Ve of anterior compartment muscles, as well as fat percentages of all three compartments ($p<0.05$). Moreover, fractional anisotropy and Ve in anterior compartment ($r=0.428$, 0.309, respectively) and fat percentages in all three compartments ($r=0.481$, 0.475, and 0.667, respectively) showed positive relationships to age ($p<0.05$). Interrater reliabilities were excellent (ICC, 0.786-0.992, $p=0.000$ for all).

CONCLUSION

Our study suggests that a number of MRI parameters are associated with age-related changes in thigh muscles. These parameters may reflect histologic and microstructural alterations in aging muscles.

CLINICAL RELEVANCE/APPLICATION

Multi-parametric MRI offers potential for non-invasive characterization of histologic changes in aging skeletal muscles. Our study provides a baseline data for further research on sarcopenia.

SSJ15-02 Fibrosing versus Non-Fibrosing Scleroderma-Related Myopathy: Role of Thigh Muscle MRI

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E450B

Participants
Shivani Ahlawat, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
Filippo Del Grande, MD, MBA, Baltimore, MD (*Abstract Co-Author*) Speaker, Siemens AG; Speaker, Bayer AG; Institutional research collaboration, Siemens AG;
Parvinder Sujlana, MD, Newport News, VA (*Abstract Co-Author*) Nothing to Disclose

Julie J. Paik, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Laura M. Fayad, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Systemic sclerosis (SSc)-associated myopathy has variable clinical outcomes. SSc patients with fibrosing myopathy (FM) have a rapidly progressive course and higher mortality than those with non-fibrosing myopathy (NFM). The purpose of our study was to describe MRI features in patients with SSc that may be predictive of FM and therefore, patient outcome.

METHOD AND MATERIALS

Following IRB approval, patients with SSc myopathy were included who had undergone a rheumatologic evaluation, thigh MRI and muscle biopsy. MRI included T1-weighted, STIR and DWI with ADC mapping (b-values 0,800 s/mm2) of both thighs. Two musculoskeletal radiologists (in consensus), without knowledge of histopathological findings, evaluated 36 individual muscles in each patient for the presence of intramuscular edema, fascial edema, fatty replacement and atrophy on all sequences using a 4-point score (absence,mild,moderate,maximal). Each patient was categorized by histologic results, as having FM (endomysial/perimysial fibrosis) or NFM (necrosis/inflammation etc.), and comparison of the two groups was performed.

RESULTS

There were 11 patients with FM (mean age 47; 9 women/2 men) and 14 with NFM (mean age 51; 10 women/4 men). Comparing STIR muscle appearance in FM (n=356) and NFM (n=498), intramuscular edema (65%(232/356) vs 49%(245/498), p<0.0001) and fascial edema (22%(79/356)vs17%(84/498), p=0.07), respectively, were more common in FM. DWI showed a greater difference in muscle signal in FM compared with NFM, at low b-value (54%(133/246) vs.23% (64/280), p<0.0001) and high b-value (46% (113/246) vs. 23%(65/280), p<0.0001) images, respectively. Minimum, average and maximum ADC values were not different between the two groups. NFM had chronic changes more often than FM, with fatty replacement (45%(223/498) vs. 26%(92/356), p=< 0.0001) and atrophy (52%(261/498) vs. 33%(118/356), p=< 0.0001), respectively.

CONCLUSION

In patients with SSc-related myopathy, intramuscular and fascial edema (as identified by STIR and DWI) on thigh MRI are more common in FM than NFM, while markers of chronic muscle damage are more often associated with NFM, potentially related to the rapid and fatal course of FM.

CLINICAL RELEVANCE/APPLICATION

Thigh muscle MRI maybe serve as an adjunct tool to distinguish between fibrosing and non-fibrosing SSc related myopathy and as such serve as a biomarker for prognosis.

SSJ15-03 Pudendal Nerve Entrapment: Comparing Pudendal MRI with Surgical Findings, Lessons Learned

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E450B

Participants
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Mario E. Castellanos, MD, Phoenix, AZ (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the performance of pudendal MRI in patients with pudendal nerve entrapment (PNE) in comparison with transgluteal pudendal neurolysis, which is the gold standard for detection of PNE caused by scar, dilated vessels, or both.

METHOD AND MATERIALS

We performed a retrospective chart review to obtain basic patient information, operative report data, and presurgical pudendal MRI findings. All patients underwent a dedicated pudendal MRI with and without contrast performed on a 1.5T scanner. Surgical and MRI data were categorized by side (left, right, or bilateral), location [anatomically narrowed spaces, either Alcock's canal (AC) or the interligamentous space (ILS)], and surgical pathology (scar, dilated vessels, or both). Data underwent sensitivity analysis, and descriptive statistics were computed using R (www.r-project.org).

RESULTS

391 patients had dedicated pudendal MRIs between 8/2010 and 12/2016. We identified 67 patients who underwent transgluteal pudendal neurolysis after MRI. There were 55 women and 12 men, whose age ranged 24 to 77 years, mean age 51. 40 surgeries were on the left side; 21 were on right side; and 6 were bilateral. The surgeons saw 70 total scars (51 in ILS, 10 in AC, and 9 in both ILS and AC) and 16 dilated vessels (12 in ILS, 2 in AC, 2 in both ILS and AC). 64 (91%) of the scars and 13 (81%) of the dilated vessels were not discernable on MRI. Only 3 (4%) MRI findings of scar and only 2 (13%) MRI findings of dilated vessels matched findings seen at surgery exactly. Though not exactly quantified at the time of surgery, small scars (<= 2 mm thickness) and mildly dilated vessels (<= 3 mm diameter) predominated the findings at surgery.

CONCLUSION

Pelvic MRI with pudendal protocol has a low detection rate of small scars and mildly dilated vessels in the interligamentous space and in Alcock's canal. In spite of the limitations of current MRI technique, from our experience, clinicians should continue to use MRI to assess for unexpected causes of pudendal nerve entrapment.

CLINICAL RELEVANCE/APPLICATION

This study quantifies the detection rate of scars and dilated vessels to further clarify the role of pelvic MRI with pudendal protocol in patients with clinically determined pudendal nerve entrapment.

SSJ15-04 Will Pre-Operative Combined MRI and HRUS Redefine Brachial Plexus Imaging? A Comparative Study of Pre-Operative MRI versus HRUS in Assessing C5, C6 Viable Root-Stump Length, a Predictor of Intra-Plexal Nerve Grafting

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E450B

Awards
Student Travel Stipend Award

Participants
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S. Devika, Vellore, India (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

MRI is the preferred imaging modality for the traumatic brachial plexus (BP) imaging. From a surgeon's perspective locating viable root stumps is important as they are a source of axons for intra-plexal grafting. Hence predicting its presence preoperatively is of high priority. We argue that the presence of a viable nerve root stump is better assessed pre-operatively with high resolution ultrasonography (HRUS) rather than MRI in patients undergoing BP surgery. This study was undertaken to compare the diagnostic accuracy of combining HRUS with MRI versus MRI alone in the preoperative assessment of viable nerve root stumps of the BP.

METHOD AND MATERIALS

After approval by the institutional review board 56 adult patients with unilateral BP injury who were planned for BP nerve surgery between July 2015 to April 2016 and consented for this prospective study were included. This cohort underwent pre-operative imaging using both MRI and HRUS and an analysis for the presence of viable nerve roots and its length if present were done using the above two modalities. Undisrupted plexuses were deemed as "continuous" while discontinuous plexuses with "viable" root stumps were termed as "present" and those without as "absent". A viable stump was one with preserved epineurium and fascicular architecture and devoid of pre-ganglionic injury. Stump lengths were measured using both imaging modalities and compared with intraoperative (IO) measurements for their concordance.

RESULTS

We observed a greater agreement between the HRUS and IO findings in categorizing BP root stumps (Kappa value 0.70) as compared to MRI and IO (Kappa value 0.42). Similarly, there was a higher correlation (intra-class correlation-ICC) of the stump length measured, between HRUS and IO (0.94) than that of MRI and IO (0.53).

CONCLUSION

Combining HRUS with MRI in the pre-operative assessment of patients with adult BP injury can predict better, the presence of viable nerve root stumps as well as accurately measure its length compared to MRI alone.

CLINICAL RELEVANCE/APPLICATION

Knowing the quality of the root stump pre-operatively will help the surgeon in choosing an appropriate nerve grafting procedure and have possible better clinical outcomes. Hence, all pre-operative BP imaging protocols should include HRUS imaging along with standard MRI sequences for a comprehensive radiological evaluation.

SSJ15-05 Parsonage-Turner Syndrome: Not a Brachial Plexitis

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E450B

Participants
Darryl B. Sneag, MD, Plainview, NY (*Presenter*) Institutional research agreement, General Electric Company
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PURPOSE

Parsonage-Turner syndrome (PTS) - commonly known as neuralgic amyotrophy and brachial neuritis - is described etiologically as a 'brachial plexitis,' implying diffuse plexus involvement, but recent electrodiagnostic research suggests otherwise. We sought to characterize lesion distribution in PTS using high-resolution MRI.

METHOD AND MATERIALS

We searched our institution's MRI database for patients with a clinical diagnosis of PTS. Two radiologists specializing in peripheral nerve MRI independently evaluated signal characteristics and morphology of the brachial plexus on high-resolution MRI, including terminal branches of the plexus, as well as peripheral nerves when imaged. A physiatrist with expertise in PTS reviewed all charts to confirm the diagnosis of PTS using history, exam, and electromyographic (EMG) findings of complete/near-complete motor loss.

RESULTS

24 patients (18 M, 6 F; age 41 ± 15 years) had >=1 clinically involved nerves: suprascapular (15), long thoracic (7), axillary (5), radial (2), anterior interosseous (2), thoracodorsal (1), phrenic (1), musculocutaneous (1), and median nerve branch to pronator

teres (1). 75% of patients developed severe weakness following a prodrome of sudden-onset intense pain, while 25% had onset >12h following a surgical procedure. Mean time between symptom onset and initial EMG was 5.5 ± 4.6 months and 8 ± 6.7 months between onset and MRI. On MRI, the plexus proper appeared normal in 21/24 patients; in 3 others, T2-weighted signal hyperintensity was seen immediately proximal to the terminal branch take-off. Focal caliber decreases of terminal branches, suggesting intrinsic constrictions, were detected in 19/24. Hyperintensity and enlargement of involved peripheral nerves were present in all patients, except the phrenic nerve (too small to identify). MRI inter-reader agreement was nearly perfect (Cohen's kappa = 0.833).

CONCLUSION

MRI findings, corroborated by EMG, localize abnormalities to the plexus branches and peripheral nerves, suggesting PTS is a mononeuropathy multiplex rather than a diffuse brachial plexitis.

CLINICAL RELEVANCE/APPLICATION

'Brachial plexitis' is a misnomer that erroneously implies diffuse plexal involvement. Accurate disease terminology may improve diagnosis and management.

SSJ15-06 T1 and T2* MRI Mapping for Detection of Early Tendon Degeneration: A Phantom Study

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E450B

Participants
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PURPOSE

To quantitatively assess early tendon degeneration using T1 and T2* mapping in healthy and chemically degenerated bovine flexor hallucis tendons

METHOD AND MATERIALS

Twelve cadaveric specimens unterwent MRI at 3T before and after chemical tendon degeneration. Fibre cross-linking or protein denaturation resembling the first or the second step of tendon degeneration was chemically induced in a total of 10 tendons. A variable-echo-time sequence and variable-flip angle sequence was used for T2* mapping and T1 mapping respectively. Each scan (untreated and treated tendons) was repeated twice at different time points and T1 and T2* times were correlated with different grades of early tendon degeneration. Standard T1- and T2-weighted spin-echo (SE) sequences were acquired for visual assessment of tendon texture. Degree of tendon degeneration was verified by histopathological analysis.

RESULTS

The degree of tendon cross-linking and denaturation ranged from mild to strong. T1 times were reproducible, showing no difference between scan 1 and 2 for untreated and treated tendons (both, $P<0.01$). The mean T1 and T2* times were significantly different between normal and degenerated tendons ($P<0.01$) and correlated well with the degree of tendon degeneration ($R=0.86$, $P<0.05$). Standard T1 and T2 SE sequences showed no visual signal differences both in treated and untreated tendons.

CONCLUSION

T1 and T2* mapping has the potential to detect and quantify early tendon degeneration before changes in tendon structure become visible on standard MR sequences.

CLINICAL RELEVANCE/APPLICATION

Early tendon degeneration in symptomatic patients might be diagnosed much earlier as with routine MR sequences.

SSJ16

Musculoskeletal (Cartilage)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451A

MK MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ16-01 Evaluation of Knee Cartilage Composition using T2 Mapping Sequences at 3T in Patients with Early Osteoarthritis Treated with Intra-articular Platelet-Rich-Plasma (PRP) Injections

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E451A

Participants
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PURPOSE

To define the ability of T2 mapping sequences to evaluate the efficacy of PRP injections characterizing qualitatively and quantitatively knee cartilage composition in patients with early osteoarthritis

METHOD AND MATERIALS

40 patients (17 men, 23 women, mean age 35.8 years), with clinical suspicion of tibiofemoral and patellofemoral chondropathy were examined on a 3T MRI scanner. T1WI, T2WI, and PDWI sequences were used for morphological evaluation of cartilage lesions, using a modified WORMS score. T2 mapping sequences were used for the qualitative and quantitative analysis of cartilage by means of color-scale representation and ROI measurements of T2 relaxation time values. Patients were assigned to 2 groups: 20 patients (group A) were treated with intra-articular PRP injections (3 times, 3 weeks apart), 20 patients (group B, control) were submitted to conservative therapy. MRI follow-up was performed at 6 months

RESULTS

Before treatment the two study groups were homogeneous in terms of age, sex and BMI. The morphologic evaluation showed mean WORMS score of 8.4 (pre-treatment) and 6.6 (post-treatment) in Group A ($p < 0.0001$). In Group B mean WORMS scores were 8.6 (pre-treatment) and 7.9 (post-treatment) ($p = 1,323$). Mean T2 relaxation times values in Group A were 51.39 ms (pre-treatment) and 44.19 ms (post-treatment) ($p < 0.001$). In Group B, 51.86ms (pre-treatment) and 50.7ms (post-treatment) ($p = 0.274$)

CONCLUSION

Our imaging results confirm the clinical evidence of the efficacy of PRP injections for the treatment of knee osteoarthritis. Evaluation of cartilage T2 relaxation times provides additional quantitative information that may not be directly discernible from standard morphological sequences

CLINICAL RELEVANCE/APPLICATION

Cartilage repair is a challenging clinical issue. The efficacy of novel therapies aiming at tissue regeneration (such as PRP) is strictly dependent on early detection of cartilage pathology and a close monitoring of the treatment effects. Characterization of the cartilage matrix composition with T2 relaxation time measurements could potentially help in prevention of OA progression, allowing better monitoring of the disease and treatment-related changes in the cartilage matrix over time

SSJ16-02 Articular Cartilage Reliably Predicts Symptomatic Osteoarthritis Progression from T2 Maps Using Transport-Based Morphometry

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E451A

Awards
Trainee Research Prize - Medical Student

Participants

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PURPOSE

Articular cartilage in the knee undergoes early biochemical changes in the development of osteoarthritis (OA). We determine whether texture change in articular cartilage as assessed by T2 maps is a reliable predictor of future symptomatic osteoarthritis.

METHOD AND MATERIALS

70 subjects (39 progressors, 31 controls) were chosen from the Osteoarthritis Initiative (OAI) database (age = 58.5 ± 9.2, BMI = 27.2 ± 4.8). At baseline, subjects had no evidence of OA either clinically (Western Ontario and McMaster Universities Arthritis Index (WOMAC) <10) or radiographically (Kellgren-Lawrence score <=2). On 3-year follow up, progressors were identified as subjects with >10 increase in WOMAC from baseline. Femoral cartilage was segmented from baseline T2 maps and co-registered. The transport-based morphometry (TBM) technique was applied to characterize T2 spatial variation within each subject individually and compared to a common template image. A penalized linear discriminant analysis classifier was constructed in the transport space and test accuracy in predicting symptomatic OA progression was determined using complete leave-two-out cross-validation. Characteristic patterns of injury were visualized through inverse TBM transformation.

RESULTS

TBM enables 86.2% test accuracy in predicting future symptomatic OA three years in advance of symptoms using T2 spatial variation of articular cartilage (sensitivity=86.6%, specificity=85.9%, Cohen's kappa = 0.72), significantly outperforming classification based on age and BMI alone. By defining signature patterns of injury in the femoral cartilage, we found that a central defect in the medial condyle and diffuse fissuring in the medial aspect of the lateral condyles were predictive of future OA.

CONCLUSION

The development of symptomatic OA can be reliably predicted based on the T2 map of knee articular cartilage using TBM, yielding the highest accuracy to date when compared to other predictive studies. In addition, TBM enables visualization of signature patterns of injury that are predictive of future OA for the first time.

CLINICAL RELEVANCE/APPLICATION

The early changes in T2 spatial variation revealed by TBM enhance our understanding of OA progression and yield markers that may be used prognostically and monitor success of disease-modifying therapies in the future.

SSJ16-03 Are Different Weight Loss Regimens in Obese and Overweight Individuals Associated With Different Degrees of Cartilage Degeneration Over 96 Months? Data from the Osteoarthritis Initiative

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E451A

Participants
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PURPOSE

To investigate MR-based cartilage biochemical degeneration and morphologic joint abnormalities over 96 months in overweight and obese subjects with stable weight and weight loss and to assess how these changes are affected by different weight loss regimens.

METHOD AND MATERIALS

Subjects with a BMI>25kg/m2 from the Osteoarthritis Initiative (n=760; age 62.6±9.0y; 465 females) with risk factors for or radiographic mild to moderate osteoarthritis were included. Subjects losing weight (>5% of baseline BMI; N=380) were frequency matched to controls with stable weight (N=380) and categorized into groups regarding the weight loss method (diet and exercise, diet only, exercise only). 3T MRI of the right knee was performed at baseline, 48- and 96-months. T2 relaxation time changes of cartilage composition, including laminar and texture analysis as well as morphological knee abnormalities, assessed with Whole-Organ-Magnetic-Resonance-Imaging-Scores (WORMS) were analyzed using mixed random effects models to calculate associations between amount of weight loss and regimen.

RESULTS

Progression of cartilage WORMS was significantly lower in the weight loss group compared to controls (P<0.001) over 96 months. Subjects with weight loss showed significantly less T2-value increase in the bone layer of all compartments (P<0.03, for each) compared to the controls with stable weight, suggesting less cartilage degeneration over 96 months in the subjects with weight loss compared to their controls. Rates of increase in cartilage T2 averaged over all compartments were lowest in the diet and diet and exercise groups compared to the stable weight group (P=0.042 and P=0.003, respectively). Weight loss through exercise alone showed no significant difference in change of T2 over 96 months compared to subjects with stable weight (P=0.56).

CONCLUSION

Results suggest that cartilage degeneration is slowed through weight loss in obese and overweight subjects over 96-months. This

protective effect was, however, only found in subjects losing weight through diet and combined exercise and diet programs.

CLINICAL RELEVANCE/APPLICATION

MR-based knee cartilage T2 measurements and semiquantitative grading allow monitoring of the protective effect of weight loss on joint health and are useful to determine which weight loss regimen is most beneficial in overweight and obese patients.

SSJ16-04 Type 2 Diabetes Patients show Accelerated Cartilage Matrix Degeneration Compared to Age, Gender and BMI-matched Diabetes Free Controls: Data from the Osteoarthritis Initiative

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E451A

Participants
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Thomas M. Link, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Research Grant, General Electric Company; Research Consultant, General Electric Company; Research Consultant, InSightec Ltd; Research Grant, InSightec Ltd; Royalties, Springer Nature; Consultant, Springer Nature; Research Consultant, Pfizer Inc;

PURPOSE

The relationship between osteoarthritis (OA) and type 2 diabetes mellitus (T2DM) is poorly understood with both diseases showing common risk factors. The purpose of this study was therefore to longitudinally investigate over 24 months cartilage matrix changes measured with MR-based T2 relaxation time including texture measurements in patients with T2DM compared to diabetes-free controls.

METHOD AND MATERIALS

Patients were recruited from the Osteoarthritis Initiative. In total 196 subjects with T2DM were group-matched for age, sex, BMI and Kellgren-Lawrence score with 196 diabetes free controls. T2DM was ascertained either by self-report or by use of anti-diabetic medication. Knee cartilage semi-automatic segmentation was performed on 2D multi-slice multi-echo spin-echo sequences; Cartilage T2 maps were calculated using a mono-exponential decay model. Texture of cartilage T2 maps was obtained with grey level co-occurrence matrix analysis, calculating the spatial distribution of neighboring pixels within the cartilage for contrast, variance, and entropy. Conditional logistic regression analysis was used to compare cross-sectional and changes in T2 and texture parameters between both groups.

RESULTS

Averaged over all compartments, subjects with T2DM increased almost twice as fast as the control group in the global knee T2 values (mean T2 (ms) [95% CI]: 1.77 [1.51,2.03] and 0.98 [0.68,1.28], respectively ($p<0.001$). The 24-month cross-sectional analysis showed significantly higher T2 values in subjects with diabetes in the global knee ($p=0.009$), patella ($p=0.01$), medial tibia ($p=0.02$), and lateral tibia (0.006). Moreover, T2DM showed texture parameters consistent with increased cartilage matrix inhomogeneity at baseline for contrast, variance and entropy ($p<0.05$) and after 24 months for contrast and variance ($p<=0.05$).

CONCLUSION

Subjects with T2DM showed a significantly faster increase in T2 values when compared to diabetic-free controls, and had also significantly higher T2 values in the cross-sectional analysis at 24 months, indicating an accelerated degeneration of the cartilage matrix. Furthermore, T2DM subjects showed more heterogeneous cartilage texture composition at both time points.

CLINICAL RELEVANCE/APPLICATION

Altered cartilage composition and collagen architecture in subjects with T2DM and accelerated cartilage matrix deterioration, suggest that T2DM is an important risk factor for OA.

SSJ16-05 MRI-Based Indicators of Patella Cartilage Volume Loss over 24-Month Interval: Initial Assessment Using Data from the FNIH OA Biomarkers Consortium

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E451A

Participants
Christopher Sereni, MD, Worcester, MA (*Presenter*) Nothing to Disclose
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Shadpour Demehri, MD, Baltimore, MD (*Abstract Co-Author*) Research support, General Electric Company; Research Grant, Carestream Health, Inc; Consultant, Toshiba Corporation;

PURPOSE

To investigate whether key patellofemoral alignment indicators on 3T magnetic resonance imaging (MRI) are associated with baseline cartilage volume differences and 2-year progression of patella cartilage volume loss.

METHOD AND MATERIALS

One index knee from each of 600 subjects in the Osteoarthritis Biomarkers Consortium FNIH project were included. Four key patellofemoral alignment markers were assessed on baseline imaging including: tibial tuberosity-trochlear groove distance (TT-TG), Insall-Salvati (IS) ratio, trochlear groove depth (TGD) and presence or absence of superolateral Hoffa's fat pad edema. Patella cartilage volume was determined at baseline and 24-month follow up MRI using validated automated software. Cross-sectional analysis of baseline data was performed by comparing cartilage volumes for each alignment index, with abnormal values considered TT-TG greater than 15 mm, IS ratio greater than 1.4, TGD greater than 3 mm, and presence of fat pad edema. Multivariable logistic regression analysis was performed with odds-ratios determined for future cartilage volume loss, adjusted for age, gender, BMI and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

RESULTS

On baseline cross-sectional analysis, abnormal IS ratio and abnormal TGD were associated with lower baseline patella cartilage volume (IS ratio: 2445 mm3 vs 2664 mm3, p:0.028; TGD: 2697 mm3 vs 2369 mm3 p<0.001). Multivariate logistic regression analysis showed only presence of superolateral Hoffa's fat pad edema to be predictive of significant 2-year interval decrease in patellofemoral cartilage volume (OR: 1.82, p: 0.003).

CONCLUSION

Presence of superolateral Hoffa's fat pad edema is associated with 2-year progression of patella cartilage volume loss. Furthermore, subjects with abnormal IS ratio and TGD had lower baseline patella cartilage volumes, suggestive of cartilage loss prior to initiation of this study.

CLINICAL RELEVANCE/APPLICATION

Routine indicators of patellofemoral alignment on MRI could allow for prediction of future patellofemoral cartilage loss.

SSJ16-06 Comparison of T2 Relaxation Values in Subtalar Cartilage between Patients with Lateral Instability of the Ankle Joint and Healthy Volunteers

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E451A

Participants
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Young Cheol Yoon, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the difference between the T2 relaxation values of the subtalar cartilage in patients with lateral instability of the ankle joint and the values in healthy volunteers.

METHOD AND MATERIALS

Twenty-seven ankle magnetic resonance imaging (MRI) examinations of 26 patients who underwent lateral ankle ligament repair between January 2011 and November 2013 were included. The datasets of previously enrolled healthy volunteers, 13 ankle MRI examinations of 12 volunteers, were used as a control group. Two radiologists independently measured the T2 relaxation values of the cartilage in the posterior facet of the subtalar joint comprising of eight compartments as follows: central calcaneus anterior (CCA), central calcaneus posterior (CCP), central talus anterior (CTA), central talus posterior (CTP), lateral calcaneus anterior (LCA), lateral calcaneus posterior (LCP), lateral talus anterior (LTA), and lateral talus posterior (LTP). The T2 relaxation values of the patient group were compared with those of the control group using linear regression analysis. Interobserver agreement and intraobserver agreement for the measurement were calculated using the intraclass correlation coefficient (ICC).

RESULTS

Readers found significantly higher mean T2 relaxation values in all compartments except that in LTP compartment measured by reader 1. For reader 1, the CCA findings were 44.9 for patients and 40.5 for healthy volunteers (p=0.002); CCP, 46.0 and 40.8 (p=0.002); CTA, 50.1 and 46.0 (p=0.001); CTP, 52.8 and 46.3 (p<0.001); LCA, 43.7 and 39.1 (p=0.002); LCP, 45.1 and 38.8 (p<0.001); LTA, 50.8 and 47.5 (p=0.019); and LTP, 50.4 and 47.6 (p=0.085). For reader 2, the CCA findings were 45.5 for patients and 41.5 for healthy volunteers (p=0.005); CCP, 45.8 and 40.1 (p<0.001); CTA, 49.7 and 45.6 (p=0.009); CTP, 52.7 and 47.0 (p<0.001); LCA, 44.3 and 39.2 (p<0.001); LCP, 45.8 and 38.8 (p<0.001); LTA, 50.4 and 47.6 (p=0.040); and LTP, 52.9 and 48.0 (p=0.002). Interobserver agreement and intraobserver agreement were excellent for all measurements (ICC>0.75).

CONCLUSION

The T2 relaxation values of the subtalar cartilage were significantly higher in patients with lateral ankle instability compared with those of healthy volunteers.

CLINICAL RELEVANCE/APPLICATION

Quantitative T2 mapping in the subtalar joint is feasible and may have a role for diagnostic evaluation of cartilage degeneration in patients with lateral ankle instability.

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SSJ17

Nuclear Medicine (Emerging Concepts and Comparative Technologies)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S505AB

BQ CT NM

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Charles M. Intenzo, MD, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ17-01 Quantitative and Visual Assessments toward Potential Sub-mSv or Ultrafast FDG-PET Using High-Sensitivity Time-Of-Flight (TOF) PET in PET/MRI

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S505AB

Participants
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PURPOSE

Newer high-performance TOF PET systems have the capability to maintain diagnostic image quality even with low count density, while maintaining a high raw photon detection sensitivity that would allow for a reduction in injection dose or rapid data acquisition. To assess this, we performed quantitative and visual assessments of the PET images acquired using a highly-sensitive large field-of-view silicon photomultiplier (SiPM)-based TOF-PET integrated with 3T-MRI in comparison to PET images acquired on non-TOF PET/CT systems.

METHOD AND MATERIALS

Whole body FDG-PET/CT was acquired for fifteen patients followed by whole body PET/MRI. The PET list mode data from PET/MRI were reconstructed using full datasets (4 min/bed) and reduced datasets (2, 1, 0.5 and 0.25 min/bed). Qualitative assessment between PET(/CT) and PET(/MR) images were made. A Likert-type scale between 1 and 5, 1 for non-diagnostic, 3 equivalent to PET(/CT) and 5 superior quality, was used. Maximum and mean standardized uptake values (SUVmax and SUVmean) of normal tissues and lesions detected were measured and compared.

RESULTS

Mean visual assessment scores were 3.54±0.32, 3.62±0.38 and 3.69±0.35 for the brain and 3.05±0.49, 3.71±0.45 and 4.14±0.44 for the whole-body maximum intensity projections (MIPs) for 1, 2 and 4 min/bed PET(/MR) images, respectively. The SUVmean values for normal tissues were lower and statistically significant for images acquired at 4, 2, 1, 0.5 and 0.25-min/bed on the PET(/MR), with values of -27±18%, -26±18%, -26±19%, -25±19% and- 25±18% ($p<0.05$) respectively. SUVmax and SUVpeak values of all lesions were higher and statistically significant ($p<0.05$) for 4, 2, 1, 0.5 and 0.25 min/bed datasets.

CONCLUSION

High-sensitivity TOF-PET showed comparable but better visual image quality even at much reduced activity in comparison to lower-sensitivity non-TOF-PET. Our data translates to a 7 times reduction in either injection dose for the same time or total scan time for the same injected dose. This 'ultra-sensitivity' PET system provides a path to extremely low-dose FDG-PET studies (e.g, sub 1 mCi injection or sub-mSv effective dose) or studies as short as 1 min/bed (e.g., 6 minutes of total scan time time) to cover whole-body without compromising diagnostic performance.

CLINICAL RELEVANCE/APPLICATION

'Ultra-sensitive' TOF PET system can provide clinically acceptable FDG-PET studies for sub-mSv or short aquisition times (1 min/bed) to cover the whole-body.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at:

SSJ17-02 SiPM PET/CT vs Standard PET/CT: A Pilot Study Comparing Semi-Quantitative Measurements in Normal Tissues and Lesions

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S505AB

Participants
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Negin Hatami, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
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Shyam Srinivas, MD, PhD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
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Andrei Iagaru, MD, Stanford, CA (*Abstract Co-Author*) Research Grant, General Electric Company

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PURPOSE

The aim of this pilot study is to determine if a new generation PET/CT scanner using silicon photomultipliers (SiPM), GE Discovery Molecular Insights - DMI PET/CT (GE Healthcare, Waukesha, WI), recently installed in our Department, provides equivalent results compared to the standard of care PET/CT scanners (GE Discovery 600 or GE Discovery 690) used in our clinic and to explore any possible differences in semi-quantitative measurements.

METHOD AND MATERIALS

We enrolled 50 patients who had a clinical indication for standard of care PET/CT. The local Institutional Review Board approved the protocol and written informed consent was obtained from each patient. All patients underwent a single injection dual imaging protocol including the standard of care PET/CT scan followed immediately by image acquisition using the DMI PET/CT scanner. We measured SUVmax and SUVmean of different background organs and up to 4 lesions per patient from data acquired using both scanners

RESULTS

DMI PET/CT scan did not miss any of the 107 lesions detected by standard PET/CT scanners and identified additional 37 areas of focal 18F-FDG uptake compatible with putative sites of disease. The results of equivalence tests, with an equivalence interval of [-0.7,0.7], performed on each of the normal tissues matched per patient showed an equivalence for all background tissues except for the cerebellum (P value < 0.01). The SUVmax measurements for all 107 lesions were 2.8 ± 2.8 higher on DMI PET/CT compared with standard of care PET/CT (P <0.0001) and this difference was not related to time delay between two scans (P <0.0001). Lesion:aortic arch ratios and lesion:liver ratios were 3.2 ± 2.6 and 1.9 ± 1.4 higher on DMI PET/CT compared with standard of care PET/CT (P <0.0001).

CONCLUSION

The performance of SiPM PET/CT is at least comparable to that of standard PET/CT. While delayed imaging can lead to detection of additional lesions, our data suggests that in this series the lesions identified only on DMI PET/CT indicate superior performance of the scanner. Further evaluation needed to confirm our data. Differences in semi-quantitative measurements between standard PET/CT and SiPM PET/CT are important factors when adopting the new technology.

CLINICAL RELEVANCE/APPLICATION

DMI PET/CT new generation scanner allow to reduce the injected dose or the scan time without missing images quality, helping to diagnose and stage disease earlier and better guide treatment strategies.

SSJ17-03 Effect of Tumor Burden on Standard Uptake Values within the Brain, Blood, and Liver: Implication for Quantitative PET/CT Imaging

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S505AB

Participants
Benjamin L. Viglianti, MD,PhD, Ann Arbor, MI (*Presenter*) Nothing to Disclose
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Ka Kit Wong, MBBS, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose
Christy Ky, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose
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Milton D. Gross, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

We have previously described the effect of patient specific factors, specifically plasma blood glucose, had on quantitative standardized uptake value (SUV) measurements within target organs/tissues of interest, particularly the relationship to brain cortical metabolism and liver parenchyma. During analysis of that patient population, there was suggestion that metabolic burden (total lesion glycolysis, TLG) either from tumor and/or heart can also be a confounding factor of FDG uptake within these reference

tissues.

METHOD AND MATERIALS

Previously published 436 FDG PET/CT studies performed for oncology staging from 229 patients (436 exams) at the Ann Arbor Veterans Administration Healthcare System were reviewed. An additional 107 exams from 50 patients were performed and TLG was obtained based on auto-segmentation of the tumor and/or the heart. The absolute and normalized uptake in target tissues for these studies were then compared to the entire group (previously published non censored data) as a function of TLG to determine if metabolic burden had an effect on uptake in reference tissue.

RESULTS

Metabolic tissue burden (tumor and/or heart) had a statistical significant effect on the uptake of FDG within reference tissue (blood, liver and brain) compared to the population average at similar plasma glucose. However, this effect was absent and or significantly mitigated when normalization to a reference tissue (blood) occurred.

CONCLUSION

The effects metabolic burden (tumor and or hear) upon brain SUV and various reference tissue can have a significant effect on absolute SUV measurements. This effect can be mitigated if normalization to a reference tissue occurs.

CLINICAL RELEVANCE/APPLICATION

Finding of this reserach could have implications in the implementation of PERCIST criteria in tumor imaging.

SSJ17-04 Whole Body Metabolic Tumor Volume is a Prognostic Marker for Overall Survival in Patients with Newly Diagnosed Stage 3B Non-Small Cell Lung Cancer Confirmed with External Validation

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S505AB

Participants
Brittany Z. Dashevsky, MD,DPhil, Chicago, IL (*Presenter*) Nothing to Disclose
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Li Yan, MD, Shandong, China (*Abstract Co-Author*) Nothing to Disclose
Cindy Yuan, MD,PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Lingyun Xiong, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Yongmei Liu, MD, Indianapolis, IN (*Abstract Co-Author*) Nothing to Disclose
Feng-Ming Kong, MD, PhD, Augusta, GA (*Abstract Co-Author*) Research Grant, Varian Medical Systems, Inc Speaker, Varian Medical System, Inc Travel support, Varian Medical System, Inc
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PURPOSE

This study aimed to evaluate the prognostic value of quantitative FDG measurements, namely whole body Metabolic Tumor Volume (MTVwb), Total Lesion Glycolysis (TLGwb), and maximum Standardized Uptake Value (SUVmaxWB), on baseline FDG PET/CT in patients with newly diagnosed Stage 3B Non-Small Cell Lung Cancer (NSCLC).

METHOD AND MATERIALS

IRB approved retrospective study identified patients diagnosed with Stage 3B NSCLC (restaged according to 8th edition TNM classification) on baseline FDG PET/CT between Feb 2004 and Dec 2014. Exclusion criteria included a second primary cancer diagnosed from 5 years before to 2 months after this FDG PET/CT scan and any prior NSCLC treatment. MTVwb, TLGwb, and SUVmaxWB were calculated from the baseline PET/CT using Edge method with Mimvista software. The study included a training dataset from one medical center, and a validation dataset from an outside hospital. The primary endpoint was overall survival (OS). Cox regression models were used to test for an association between patient characteristics, quantitative FDG measurements and OS.

RESULTS

110 patients with clinical Stage 3B NSCLC met inclusion/exclusion criteria. 78.2% expired during follow-up. The median OS was 14 months. 1-year, 2-year, and 5-year OS was 56.5%, 34.6% and 13.9 %, respectively. The median follow-up among survivors was 26.0 months (inter-quartile range 13.6 to 57.2 months). Univariate analysis showed no significant difference in OS on the basis of age, gender, histology, ln(TLGwb), or ln(SUVMAXwb). However, increasing ln(MTVwb) was associated with worse OS (hazard ratio (HR) of 1.23). This association persisted on multivariate Cox regression analysis (HR of 1.28), when adjusted for age, gender, treatment and tumor histology. The second external dataset of 44 patients validated the significant correlation between MTVwb and survival. Specifically, a MTVwb cut-off point of 85.6 mL able to further stratify patient prognosis among patients with Stage 3B NSCLC, with increasing MTVwb predictive of significantly worse survival.

CONCLUSION

MTVwb is a prognostic marker for OS in patients with Stage 3B NSCLC, independent of age, gender, treatment, and tumor histology, with increasing MTVwb predictive of significantly worse OS.

CLINICAL RELEVANCE/APPLICATION

An MTVwb of 85.6 mL may be used as a threshold to further stratify Stage 3B NSCLC patients, with MTVwb >= 85.6 mL on baseline PET/CT predictive of worse prognosis.

SSJ17-05 Who is Hot and Who is not? The Diagnostic Dilemma of Paraneoplastic Syndromes and Who to Image with FDG-PETCT

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S505AB

Awards
Student Travel Stipend Award

Participants
Sophie E. West, MBBS, MSc, London, United Kingdom (*Presenter*) Nothing to Disclose
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Nimesh Shah, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Jane Evanson, MD, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Paraneoplastic syndromes are a rare phenomenon that pose a diagnostic challenge and are sometimes the first clinically detectable evidence of occult disease.:The dilemma occurs as many of the signs/symptoms associated with them can be features of conditions without an underlying malignancy.Given the higher radiation doses associated with a full body FDG-PETCT over conventional CT or non-ionising radiation imaging we wanted to evaluate its usefulness as a first line investigation for patients with suspected paraneoplastic syndromes.The challenge is 'who to PETCT?'.

METHOD AND MATERIALS

We conducted a retrospective review of patients who underwent FDG PETCTbetween 01/01/2009 and 31/01/2017, to investigate occult malignancy in suspected paraneoplastic syndrome. We collected information on age, sex, primary diagnosis, incidental pathology, other causative pathology, presence of antibodies and final diagnosis. Evaluation of cases where a positive neoplasm was identified was carried out to evaluate if other first line investigations were obtained, and if not, would alternative imaging have been suitable.

RESULTS

113 patients were identified as having PETCT. 3.5% (n=4) had a primary neoplasm identified. The commonest source of referral was from neurology n=73 (64%), followed by rheumatology (n= 38, 34%), and endocrinology (n=2, 2%). In our study, PETCT had a true positive = 4, true negative = 94, false positive = 14, false negative = 1. The PPV was 22%, NPV was 98%, sensitivity was 80% and the specificity was 87%. A review of the positive cases was carried out to identify if other imaging would have yielded the same result. The neoplasms identified were oropharyngeal, primary lung, phaemochromocytoma and Hodgkins lymphoma. 75% of malignancy detected on PETCT was also detectable on conventional CT.

CONCLUSION

To our knowledge this is the largest retrospective analysis in the UK of PETCT in the investigation of patients with suspected paraneoplastic syndrome. PETCT has a high NPV and is therefore an excellent diagnostic test to exclude malignancy. The low positive yield for malignancy adds support to our current national imaging and neurology guidelines which advise against using PETCT as a first line investigation.

CLINICAL RELEVANCE/APPLICATION

Paraneoplastic syndromes are a diagnostic challenge. Radiation burden and resource management must be considered when deciding on the primary radiological investigation.

SSJ17-06 Synthesis, Quality Control and Bio-Distribution of PET Tracer (18F-FP-Chlorotoxin) and Preliminary Evaluate the Imaging Features of 18F-FP-Chlorotoxin in C6 Glioma Model

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S505AB

Participants
Jing Zhao JR, MD, PhD, Guang Zhou, China (*Presenter*) Nothing to Disclose
Jian-Ping Chu, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Yuliang Wang, Guang Zhou, China (*Abstract Co-Author*) Nothing to Disclose
Xin-Bei Li, BDS, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Yukun Song, MD, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Ganghua Tang, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To synthesize, describe the bio-distribution of 18F-FP-Chlorotoxin and do quality control of this PET-tracer. Further, to preliminary evaluate its imaging feature in C6 glioma model.

METHOD AND MATERIALS

18F- was generated by medical cyclotron and 18F-NFB was synthesized through fluorination reaction, then, dissolved 18F-NFB and Chlorotoxin in Na2HPO4 or borate buffer. Quality control experiments of 18F-FP-Chlorotoxin were performed. 20 normal Kunming mice were randomly divided into four groups and each mouse was injected 18F-FP-Chlorotoxin (22-23 μCi) via the tail vein. They were sacrificed after injection in 10 min, 30 min, 60 min and 120 min, respectively. Blood and organs of each mouse were resected and weighed separately. 18F-FP-Chlorotoxin (60min, 90min, 120min) and 18F-FDG micro PET-CT (60min) was performed on the same rat with orthotopic C6 cell-bared glioma (n=2) at different scan time points and their imaging features were analyzed.

RESULTS

18F-FP-Chlorotoxin was successfully made. The chemical purity of 18F-FP-Chlorotoxin was greater than 98% and the radiation purity was greater than 95%. The brain had a low and relatively stable uptake of 18F-FP-Chlorotoxin and, it was 0.37±0.10% ID/g in 10 min which was slightly decreased to 0.28±0.06%ID/g in 60min. Among all the organs, kidney showed the highest uptake. 18F-FP-Chlorotoxin and 18F-FDG micro PET-CT were successfully performed on the same rat with orthotopic C6 cell-bared glioma. Compared with 18F-FDG, a low uptake of 18F-FP-Chlorotoxin was detected in normal brain parenchyma while a higher level of 18F-FP-Chlorotoxin was found in the gliomas tissue. The glioma tumor/normal brain parenchyma in 18F-FP-Chlorotoxin was higher than the ratio in 18F-FDG. Further, the diagnostic performance of 18F-FP-Chlorotoxin in 90 min was better than it in 60 min.

CONCLUSION

The main quality control indexes of 18F-FP-Chlorotoxin had reached the positron radiopharmaceuticals quality requirements. Normal brain parenchyma has a low and stable uptake on 18F-FP-Chlorotoxin and, compared with 18F-FDG, 18F-FP-Chlorotoxin has a better performance in diagnosis of glioma.

CLINICAL RELEVANCE/APPLICATION

18F-FP-Chlorotoxin as a new PET-trace with a low and stable uptake in normal brain parenchyma and, compared with 18F-FDG, it has a better performance in diagnosis of glioma.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSJ18

Neuroradiology/Head and Neck (State-of-the-Art Thyroid and Parathyroid Imaging)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N226

NR HN

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Nancy J. Fischbein, MD, Stanford, CA (*Moderator*) Nothing to Disclose
Kristen L. Baugnon, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ18-01 Thyroid Nodule Assessment: Initial Experience with the New ACR TI-RADS Guidelines

Tuesday, Nov. 28 3:00PM - 3:10PM Room: N226

Participants
Declan G. Sheppard, MD, Galway, Ireland (*Presenter*) Nothing to Disclose
John F. Bruzzi, MBBCh, Galway, Ireland (*Abstract Co-Author*) Nothing to Disclose
Diane Bergin, MD, Galway, Ireland (*Abstract Co-Author*) Nothing to Disclose
Patrick Navin, MBBCh,MRCPI, Galway, Ireland (*Abstract Co-Author*) Nothing to Disclose
Arlene Weir, MBBS, Galway, Ireland (*Abstract Co-Author*) Nothing to Disclose
Bruno Voisin, PhD, Galway, Ireland (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The new ACR TI-RADS guidelines were published on-line on March 31st 2017 http://dx.doi.org/10.1016/j.jacr.2017.01.046 Existing guidelines can be difficult to apply. The new risk stratification model was published with the aim of reducing the number of unneccessary thyroid biopsies. Our study aims to: 1. Determine the accuracy of the new guidelines 2. Look specifically at the biopsy rates and the number of malignancies that might be missed with the application of these new guidelines.

METHOD AND MATERIALS

The new guidelines were applied against a pre-existing electronic database of 200 pathologically confirmed cases. 200 cases had already been scored by 5 readers (4 using a newly developed on-line 'app') using an extended version of the 2015 ACR TI-RADS lexicon. The sonographic features scored included the ACR lexicon which had been extended to allow for the assessment against the pre-existing ATA, AAC/AME/ETA, BTA, Kim, Koreean, ASRU and a number of the earlier versions of 'TI-RADS' scoring system. The readers included 3 faculty (> 10 years post fellowship training), a 4th year Resident and an intern(planning a career in Radiology) - all had been involved with thyroid US projects previously.

RESULTS

Using the summed scores of all readers the mean sensitivivity for the new ACR TI-RADS was 57% (range,40-93) while the specificity was 52% (range, 42-60). Initial experience from the readers that it was slow to use but with time productivity improved sunstantially. Average time with experience varied from 40 sec to 5 min. Less experienced users were more likely to use if available as a clinical decision support tool.

CONCLUSION

Initial experience with the new guidelines might suggest a lower specificity and consequently the expected reduction in biopsy numbers may not be achieved. A slightly lower sensitivity for biopsies is compensated for by combining the true positive biopsy rate and the follow-up rate of the 'false negatives' The app may be more useful for less experienced operators

CLINICAL RELEVANCE/APPLICATION

Further investigation is required to determine whether the new ACR guidelines constitute the correct balance of sensitivity and specificity to reduce the number of unnecessary thyroid biopsies while avoiding missing clinically signifcant cancers.

SSJ18-02 Preliminary Study on Spectral Parameters of Various Pathological Types of Malignant Tumors of Thyroid

Tuesday, Nov. 28 3:10PM - 3:20PM Room: N226

Participants
Lin Li, MD, Beijing, China (*Presenter*) Nothing to Disclose

PURPOSE

To analyze the imaging manifestations and spectral parameters of various pathological types of malignant tumors of thyroid.

METHOD AND MATERIALS

67 cases of malignant tumors of thyroid were included in the retrospective study(44 papillary carcinomas, 2 follicular carcinomas,9 medullary carcinomas, 7 anaplastic carcinomas and5 primary thyroid lymphomas). The morphological manifestations and the spectral parameters were analyzed. All the patients underwent spectral CT scan with Discovery CT750HD scanner in GSI mode. The morphological manifestations of lesions were analyzed on the optimal monochromatic images. The iodine concentration (IC), water concentration (WC), normalized iodine concentration (NIC),spectral HU curve slope values (λHU) were measured and analyzed by GSI Viewer. SPSS 19.0 software was used for statistical analysis of the data.

RESULTS

The morphological features of malignant tumors of thyroid were as follows: single lesion (57 cases, 85.1%), irregular shape (46 cases, 68.7%), indistinct margin (45 cases, 67.2%), heterogeneous density (48 cases, 71.6%) and detection of calcification (21 cases, 31.3%). There was no significant difference among various types of malignant tumors on WC($P>0.05$). The IC, NIC and λHU values of papillary carcinoma, follicular carcinoma and medullary carcinoma were higher than that of anaplastic carcinoma and lymphoma($P<0.05$). The NIC of papillary carcinoma was lower than that of medullary carcinoma($P>0.05$).There were no significant differences on the parameters between each two groups remained($P>0.05$).

CONCLUSION

The morphological features and spectrum parameters are different in various pathological types of thyroid malignant tumors, and it is helpful for the diagnosis and differential diagnosis.

CLINICAL RELEVANCE/APPLICATION

Spectral CT imaging is helpful to differentiate various pathological types of thyroid malignant tumors.

SSJ18-03 Computer-aided Diagnosis System for Thyroid Nodules on Ultrasound: Initial Clinical Experience

Tuesday, Nov. 28 3:20PM - 3:30PM Room: N226

Participants
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Eun Ju Ha, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Miran Han, MD, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To prospectively evaluate the diagnostic performance of a computer-aided diagnosis (CAD) system (S-Detect for ThyroidTM) for thyroid US in the differential diagnosis of thyroid nodules and to determine interobserver agreement between the CAD system and experienced radiologist.

METHOD AND MATERIALS

This study was approved by the ethics committee of the institution, and all patients provided written informed consent. We consecutively enrolled patients with thyroid nodules with final diagnoses whether benign or malignant between June 2016 and July 2016. An experienced radiologist reviewed US characteristics of thyroid nodules, and a CAD system provided nodule diagnosis whether benign or malignant in a prospective design. We compared the diagnostic performance of experienced radiologist, CAD system, and CAD system assisted radiologist for detecting thyroid cancer and determined interobserver agreement between the CAD system and experienced radiologist.

RESULTS

A total of 117 thyroid nodules from 50 consecutive patients were included. The mean size of nodules was 1.5 ± 1.1 cm (range: 0.5-10.0 cm) and final diagnoses were 67 (57.3%) benign nodules and 50 (42.7%) malignant nodules. The CAD system showed similar sensitivity and specificity compared with the experienced radiologist (sensitivity: 80.0% versus 87.0%, P= 0.754; specificity: 88.1% versus 95.5%, P= 0.180). The diagnostic accuracy was not significantly different between the CAD and experienced radiologist (84.6% versus 90.6%, P= 0.646). The CAD system assisted radiologist reached the higher diagnostic sensitivity when compared to the radiologist without the CAD system (91.8% versus 87.0%, P= 0.031). The interobserver agreement between radiologist and CAD system were substantial agreement for a final diagnosis (kappa=0.661).

CONCLUSION

The diagnostic performance of CAD system for differentiating thyroid nodule was as good as that of the experienced radiologist with a substantial agreement. The CAD system assisted radiologist could achieve the highest diagnostic sensitivity for thyroid cancer.

CLINICAL RELEVANCE/APPLICATION

The CAD system could be used as a good decision-making supporter for the experienced radiologist with achieving the highest sensitivity up to 91.7% as well as for the beginner or non-thyroid radiologist with achieving comparable diagnostic performance with the experienced radiologist.

SSJ18-05 Can 4D-MRI Be an Alternative Modality for the Detection of Parathyroid Lesions in Primary Hyperparathyroidism?

Tuesday, Nov. 28 3:40PM - 3:50PM Room: N226

Participants
Devasenathipathy Kandasamy, MBBS, New Delhi, India (*Presenter*) Nothing to Disclose
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Nikhil Tandon, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Seenu Vuthaluru, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Nishikant Damle, MD, Delhi, India (*Abstract Co-Author*) Nothing to Disclose

Arun K. Gupta, MBBS,MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To compare ultrasonography (USG), Tc99 MIBI, 4D-CT & 4D-MRI in the detection & localisation of parathyroid lesion in patients with primary hyperparathyroidism (PHPT).

METHOD AND MATERIALS

In this prospective institutional ethics committee approved study, 39 patients with PHPT underwent USG, 4D-CT, 4D-MRI & Tc99 MIBI in the period, May 2016 - Feb 2017. Children & pregnant patients was excluded from study. 4D-CT was performed in 3 phases (NCCT, arterial & venous) on a 256 slice scanner & 4D-MRI was performed on a 1.5T scanner. Sixteen patients underwent surgery & only those were included for analysis. Surgical findings confirmed on histopathology & normalisation of parathormone (PTH) after excision of lesion were taken as the gold standard. The images were analysed for the presence & quadrant wise location of parathyroid lesions by two experienced radiologists & a nuclear medicine physician.

RESULTS

Of the 16 patients analysed, parathyroid hyperplasia was seen in 2 (12.5%), parathyroid adenoma in 12 (75%) & parathyroid carcinoma were found in 2 (12.5%) patients. In all patients, preoperative localisation was confirmed at surgery & this included ectopic lesions (mediastinum & parapharyngeal region) in two patients. PTH values returned to normal after surgery in all patients. 4D-CT, 4D-MRI showed 100% sensitivity whereas USG & MIBI showed 81.25% sensitivity each, for lesion detection & quadrant localisation. Two ectopic parathyroid adenomas were missed on USG & MIBI scan.

CONCLUSION

4D-CT & 4D-MRI had a high accuracy for parathyroid lesion detection & localisation in patients of PHPT whereas USG & MIBI showed moderate accuracy. 4D-MRI, being a modality without radiation exposure may provide a viable alternative for the localisation of parathyroid lesions.

CLINICAL RELEVANCE/APPLICATION

4D-CT & 4D-MRI have comparable high accuracy for detection & localization of parathyroid lesions in patients with PHPT. Due to better safety profile, the latter may become the modality of choice in the future

SSJ18-06 Parathyroid Adenoma Identification Using Spectral Dual Energy CT Texture Analysis

Tuesday, Nov. 28 3:50PM - 4:00PM Room: N226

Awards
Student Travel Stipend Award

Participants
James W. Alexander, MSc, Montreal, QC (*Presenter*) Nothing to Disclose
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Maryam Bayat, Montreal, QC (*Abstract Co-Author*) Nothing to Disclose
Gabriel Melki, Montreal, QC (*Abstract Co-Author*) Nothing to Disclose
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Reza Forghani, MD, PhD, Cote-saint-Luc, QC (*Abstract Co-Author*) Consultant, General Electric Company; Consultant, Real-Time Medical, Inc; Stockholder, Real-Time Medical, Inc; Committee member, Real-Time Medical, Inc

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PURPOSE

The purpose of this study was to (1) determine the accuracy of texture analysis performed on multi-energy or single energy (65 keV) virtual monochromatic images (VMIs) from dual energy CT (DECT) scans for parathyroid adenoma classification and (2) to compare accuracy using a single phase or multiple phases from the 4D-DECT scan.

METHOD AND MATERIALS

16 patients with pathologically proven parathyroid adenomas having a 3-phase 4D-DECT including a non-contrast (NC), arterial (CTA), and delayed phase (DEL) scan were included. Texture analysis was performed using a commercial software (TexRAD®) by manually delineating a region of interest around the largest diameter of the PA, thyroid, and a lymph node on VMIs ranging from 40 to 140 keV in 5 keV increments or VMIs at 65 keV alone. Random forests (RF) models were constructed using various histogram-based texture features for outcome prediction with internal cross-validation in addition to use of separate randomly selected training and validation sets. Sensitivity (Sens), specificity (Spec), positive predictive value (PPV), and negative predictive value (NPV) were determined for PA distinction from thyroid tissue or lymph nodes.

RESULTS

With RF models, the highest accuracy for PA prediction was achieved using a combination of NC-CTA-DEL phases with estimated Sens, Spec, PPV, and NPV of 100%. The CM-CTA and CTA-DEL combinations had similar accuracy with Sens, Spec, PPV, and NPV of 100%, 90%, 83%, and 100%, respectively. Multi-energy analysis was superior to analysis of 65 keV VMIs alone. For the latter, the highest accuracy achieved was Sens, Spec, PPV, and NPV of 60%, 100%, 100%, and 83%, respectively.

CONCLUSION

Multi-energy VMI texture analysis can correctly classify PAs with high accuracy at least similar to an expert radiologist, and is

superior to texture analysis of single energy image sets at 65 keV.

CLINICAL RELEVANCE/APPLICATION

DECT texture analysis has high accuracy for PA identification, improving diagnostic performance or potentially enabling a reduction in the number of phases acquired and patient radiation exposure.

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103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSJ19

Neuroradiology (Machine Learning and Deep Learning)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N228

IN NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Greg Zaharchuk, MD, PhD, Stanford, CA (*Moderator*) Research Grant, General Electric Company; Consultant, General Electric Company;
Amit M. Saindane, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ19-01 Improving Cerebral Blood Flow and Transit Time Measurement in Arterial Spin Label MRI with Deep Learning

Tuesday, Nov. 28 3:00PM - 3:10PM Room: N228

Participants
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Jia Guo, PhD, Stanford, CA (*Abstract Co-Author*) Research support, General Electric Company
John Pauly, Stanford, CA (*Abstract Co-Author*) Research support, General Electric Company
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PURPOSE

The risk of under-estimating local CBF in cerebrovascular disease patients as well as the underlying low SNR of the arterial spin labeling(ASL) techniques calls for new approaches. Here we proposed and evaluated a Deep Learning method to boost image quality and improve cerebral blood flow(CBF) and arterial transit delay(ATD) estimation using multi-delay ASL.

METHOD AND MATERIALS

We developed a Deep Learning based method, a local Residual-Encoder-Decoder Convolutional Neural Network (CNN), to improve the ASL image quality. At 3T, we collected two multidelay ASL datasets in 7 normal subjects: (1) input images: low SNR/resolution (5.6mm resolution,1 repetition,4min); (2) gold-standard reference images: high SNR/resolution (3.8mm resolution,3 repetitions,24min). Label Duration(LD) was 2sec and 5 Post-Labeling-Delays(PLD) were used (0.7sec,1.4sec,2.1sec,2.8sec,3.5sec). We trained the network to reduce artifact/noise in the input ASL images by approximating the gold-standard reference images. The method takes in image patches from low-SNR/resolution ASL and the corresponding un-labeled proton-density-weighted data, forward-passes through the network and outputs improved image patches to approximate the high-resolution-high-SNR patches from the gold-standard reference ASL. Once trained, we applied the model to improve new ASL clinical scans which do not necessarily include gold-standard reference scans (n=5, patients with cerebrovascular and neoplastic disease). Application of the model is efficient, requiring only 1 sec per slice to apply.

RESULTS

To evaluate the proposed method, we compared the error metrics(normalized RMSE and PSNR) between the model outputs and the gold-standard reference. It showed the proposed method could reduce RMSE from 29.3% to 10.8% and increase PSNR by 4.3 dB on average. For data with pathology we compared the ASL images, CBF maps and ATD maps, demonstrating that the proposed method preserves the pathology while significantly improving the ASL image quality.

CONCLUSION

The proposed Deep Learning method significantly reduces(6 fold) the acquisition time required to obtain high-quality ASL imaging, improving CBF estimation and more detailed ATD maps in clinical patients.

CLINICAL RELEVANCE/APPLICATION

The proposed Deep learning method significantly improves ASL image quality, reduces scan time and increases SNR/resolution, potentially allowing it to be used in a wider variety of clinical settings.

SSJ19-02 Texture Analysis for Differentiating Glioblastoma Multiforme and Primary Cerebral Lymphoma: Benefits of Machine Learning Based on Multi-parametric MRI

Tuesday, Nov. 28 3:10PM - 3:20PM Room: N228

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PURPOSE

To determine whether a prediction model using machine learning based on multi-parametric magnetic resonance imaging (MRI) texture features can offer adequate diagnostic performance for differentiating glioblastoma multiforme (GBM) and primary cerebral lymphoma (PCL).

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board. The requirement to obtain informed consent was waived. We included 70 patients who underwent contrast enhanced brain MRI at 3T with brain tumors diagnosed as GBM (n = 45) and PCL (n = 25). We measured minimum value, mean value, standard deviation and maximum value in apparent diffusion coefficient (ADC) and cerebral blood volume (rCBV), and eight types of histogram and texture parameters (skewness, kurtosis, homogeneity, energy, contrast, correlation, entropy, dissimilarity) for ADC, rCBV, T2 weighted images (T2WI), and contrast-enhanced T1WI (CE-T1WI). We developed a prediction model using a machine learning method (extreme gradient boosting) and calculated the area under the receiver operating characteristic (ROC) curve of this model via 10-fold cross validation. In addition, we compared the performance of machine learning with the judgments of two board certified radiologists.

RESULTS

Skewness in CE-T1WI had the strongest influence (GBM 0.237 ± 0.439; PCL -0.328 ± 0.679, p = 0.0006), followed by standard deviation in rCBV (GBM 703.4 ± 337.0; PCL 382.9 ± 223.1, p < 0.0001), mean ADC value (GBM 1.379 ± 0.403; PCL 1.114 ± 0.209, p = 0.0005), kurtosis in CE-T1WI (GBM 2.612 ± 0.644; PCL 4.998 ± 1.796, p = 0.0009), and skewness in rCBV (GBM 1.100 ± 0.663; PCL 1.799 ± 1.222, p = 0.0124). Validation analysis showed that the AUC for the machine learning method and the two radiologists were 0.90, 0.84 and 0.79, respectively.

CONCLUSION

The performance of machine learning based on texture futures in multi-parametric MRI was comparable to that of experienced radiologists in differentiating GBM and PCL.

CLINICAL RELEVANCE/APPLICATION

The current results suggest that machine learning based on texture features with multi-parametric MRI may provide a useful method for differentiating GBM and PCL.

SSJ19-03 Radiogenomics of Glioblastoma: Prediction of Molecular Subtype by Using Multiregional MR Imaging Features and Machine Learning Techniques

Tuesday, Nov. 28 3:20PM - 3:30PM Room: N228

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PURPOSE

To evaluate the association between multiregional radiomic features from MR imaging and molecular subtypes in patients with newly diagnosed glioblastoma.

METHOD AND MATERIALS

Preoperative MR imagings from 121 consecutive patients with newly diagnosed glibolastoma were retrospectively reviewed. 787 multiregional (contrast-enhancing regions and hyperintense regions at FLAIR images) radiomic features were extracted from on postcontrast T1-weghted, T2-weighted, FLAIR images, and ADC map. Molecular subtypes consisting of MGMT promoter methylation, IDH1 mutation, EGFR amplification and 1p/19q codeletion status were reviewed. The features that showed significant

difference (<0.05 by Wilcoxon test) or discriminative value (area under the receiver operating characteristics curve [AUROC] > 0.7) were selected on univariate test, and redundant features were removed. The strength of association between selected radiomic features and molecular subtypes was assessed via machine learning algorithms (stochastic gradient boosting machine, penalized logistic regression, and random forest). To prevent overestimation and overcome data imbalance, bootstrapping with 100 repetition and data subsampling were performed.

RESULTS

On univariate analyses, 11, 9, 6 and 15 radiomic features remained after removing redundant features to predict MGMT, IDH1, EGFR, and 1p/19q codeletion status, respectively. Applying machine learning to radiomic features yielded moderate performance (AUROC : 0.691-0.800) to predict MGMT status, and good to excellent performance to predict IDH1 mutation (AUROC : 0.868-0.971), EGFR amplification (AUROC : 0.729-0.874) and 1p/19q codeletion status (AUROC : 0.771-0.960). Nonetheless, in terms of accuracy, only a few machine learning models showed higher accuracy than prediction by change, which was resulted from data imbalance.

CONCLUSION

The authors found associations between MR radiomic features and molecular subtypes, although some of them may not be significant considering the data imbalance and prediction by chance.

CLINICAL RELEVANCE/APPLICATION

Radiomic profiling may have association with molecular subtypes in glioblastoma, although some of them may not be significant considering the data imbalance and prediction by chance.

SSJ19-04 Machine Learning Prediction and Classification of Working Memory Performance Based on Brain Microstructure in Healthy Adults: A Diffusion Kurtosis Imaging Study

Tuesday, Nov. 28 3:30PM - 3:40PM Room: N228

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PURPOSE

The goal of this study is to predict working memory performance based on white matter (WM) microstructure in healthy adults by using machine learning approaches. White matter tract integrity (WMTI) metrics as well as diffusion tensor imaging (DTI) and diffusion kurtosis imaging (DKI) metrics were used to assess WM microstructure, and WAIS-IV letter-number sequencing (LNS) test was used to assess working memory.

METHOD AND MATERIALS

We studied 21 healthy individuals (34±9m 19-50 years old) using a 3T MR scanner (Skyra, Siemens). DKI was performed with 5 b-values (up to 2.5ms/μm2 with up to 60 directions). WMTI (axonal water fraction (AWF), intra-axonal diffusivity, extra-axonal axial/radial diffusivities, extra-axonal tortuosity (a)), DTI (FA, MD, AD, RD) and DKI (MK, RK, AK) metrics were calculated. Tract-based spatial statistics (TBSS) was performed with age and gender as covariates to test for significant correlations between diffusion metrics and LNS z-scores. For each metric, regions-of-interest (ROIs) were selected if $p<0.1$ after family-wise error (FWE) correction, and then were averaged as input features. The gradient boosted regression trees (GBRT) model was used to predict LNS and Logistic regression was used to classify individuals into arbitrary groups with LNS z-score above 1, below -1 and in between ±1. All data were randomly split into train (70%) and test (30%) sets.

RESULTS

Fig.1 shows ROIs for AWF, tortuosity a, FA, MK, and RK that were positively correlated with LNS. Using all 5 metrics as input features, we achieved a 95.4% accuracy in predicting LNS and a 79.6% accuracy in classifying individuals into two groups with LNS z-score above 1 and in between ±1 (Fig.2)

CONCLUSION

This study shows WM microstructural associations with working memory which can be predictable by using machine learning approaches. Our findings of higher AWF and tortuosity a with better performance on LNS go along with greater number of axons and greater myelination in these regions, causing efficient and faster information processes. Our results demonstrate the potential utility of diffusion metrics to serve as early biomarkers of working memory impairment.

CLINICAL RELEVANCE/APPLICATION

Our study elucidates the underlying relationship between white matter microstructure and working memory, and raises the potential utility of diffusion metrics to predict impairment of working memory.

SSJ19-05 Estimating the Age from Time of Flight MR Angiography Using Deep Learning

Tuesday, Nov. 28 3:40PM - 3:50PM Room: N228

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PURPOSE

Age-related changes involve the brain vasculatures as well as the brain itself. Previous studies suggested that time of flight MR angiography (TOF-MRA) could visualize morphological changes of aged intracranial arteries. Because atherosclerotic changes were similar with changes of aged brain arteries histopathologically and morphologically, findings of brain TOF-MRA could be used as a biomarker of aging and other age-related changes. However, previously suggested analysis using hand-crafted features were limited to formulate an integrated biomarker for various features. Moreover, developing quantitative indices for those features is very challenging. To overcome these limitations, we introduced deep learning to estimate the age-related changes from TOF-MRA, instead of developing domain-knowledge based analysis. In this study, we investigate the feasibility of deep learning as a tool to extract and quantify age-related change of brain vasculatures.

METHOD AND MATERIALS

A total 954 TOF-MRA images were collected from two public databases of healthy volunteer and our own database of participants without any neurological or neurovascular disease. A deep neural network based on Alexnets was trained using axial MIP images as input data and actual ages as labels to minimize mean absolute errors (MAE) using TensorFlow framework. Spatial normalization and data augmentation were performed before train. For training and validation purpose, 689 subjects (augmented to 22,737) and 93 subjects were used. Remaining 203 subjects were used as test set. To evaluate the model accuracy, correlation coefficients (r) and MAE were calculated.

RESULTS

A deep learning model was built to estimate subjects' age solely using TOF-MRA successfully. For validation set, high correlation coefficient (r=.847) with good MAE (6.774) was obtained. For test set, performance was slightly decreased (r=.825, MAE= 7.765), but results were acceptable. Using trained network, a subject's age can be estimated from TOF-MRA data within a second.

CONCLUSION

We demonstrated the potential of deep learning technology for the assessment of age from the brain MRA. Estimated age from TOF-MRA showed good concordant with subject's biologic age.

CLINICAL RELEVANCE/APPLICATION

Estimated age from TOF-MRA can be used as an imaging biomarker for the brain vasculature. For example, a subject with atherosclerosis might have higher estimate age from brain TOF-MRA than subject's biological age.

SSJ19-06 Convolutional Neural Network based Deep Learning to Diagnosis the Sinusitis with Paranasal Sinus X-Ray

Tuesday, Nov. 28 3:50PM - 4:00PM Room: N228

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PURPOSE

Sinusitis is diagnosed by the opacification of the sinuses and air/fluid level best seen in the maxillary sinus with the paranasal sinus (PNS) X-ray scan. It is hard to represent these features to discriminate sinusitis from normal cases. Deep learning is a branch of machine learning used in acquiring useful representation of features directly from data. The most important factors that determine the performance of deep learning is data quality and quantity. The objective of this study was to investigate the ability of deep learning to improve the diagnosis of sinusitis using the PNS X-ray image.

METHOD AND MATERIALS

A total of 496 patients, which included 248 normal and sinusitis subjects each, underwent PNS X-ray scan. All subjects were independently labeled twice by two radiologists. We used three input data type to investigate the efficiency classification tuning: 1) 248 images without patch and data augmentation, 2) 992 images with data augmentation that is rotated data, and 3) 992 images with extracted maxillary sinus patch and rotated data. We implemented on the data to differentiate between normal and sinusitis subjects with the AlexNet convolutional neural network (CNN) model for imaging classification. Finally, classification results were quantitatively assessed by accuracy.

RESULTS

We compared the results of our approaches to optimize classification model. The results of accuracy for training/test data set were 70.3 %/60.9 %, 75.6 %/59.6 %, and 75.6 %/59.6 %, , respectively. Fig.1 shows that representation for the learned hierarchical feature maps with PNS X-ray image. Original data: a (normal) and e (sinusitis), Patched data: b (normal) and f (sinusitis), Feature maps: .c (1st layer), g (2nd layer), d and h (normal and sinusitis in final fully connected layer, respectively). Arrow indicates the characteristic to evaluate the sinusitis in the maxillary sinus.

CONCLUSION

The diagnosis for sinusitis using deep learning with PNS X-ray depends on the quantity and quality of data. To improve the accuracy of sinusitis, it is necessary to run the pre-processing steps such as extracted patch and data augmentation. Deep learning with PNS X-ray can be used to classify between normal and sinusitis cases.

CLINICAL RELEVANCE/APPLICATION

Optimized deep learning study with PNS X-ray image can demonstrate to be used to classify normal and sinusitis cases indicating it as a practical method for early diagnosis.

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SSJ20

Neuroradiology (Neurointerventional Radiology)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N229

NR IR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ20-01 Prior IV tPA in Mechanical Thrombectomy for Acute Ischemic Stroke: Technical Details and Clinical Significance

Tuesday, Nov. 28 3:00PM - 3:10PM Room: N229

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PURPOSE

This study aimed to assess the impact of intravenous (IV) tPA treatment before mechanical thrombectomy in acute ischemic stroke patients.

METHOD AND MATERIALS

We studied patients prospectively included in SONIIA registry (2011-2015), a mandatory, externally audited registry that monitors the quality of reperfusion therapies in Catalonia. We included the total number of thrombectomy cases from all participant centers to simulate "real-world" clinical practice. Analysis and outcome parameters: any recanalization (TICI >=2a), complete recanalization (TICI >=2b), procedural time, symptomatic intracranial hemorrhage (SICH), neurological improvement (>=4 points decrease in the NIHSS score at 24 hours), independent functional outcome (mRS <=2), mortality at three months.

RESULTS

Among the 1640 patients included, 48.1% received IV tPA. Mean age at treatment was 67.5±13.5, 54.4% male. Diabetes mellitus (p=0.024), atrial fibrillation (p<0.001), and ischemic cardiomyopathy (p=0.018) prevalence rates were higher in IV tPA patients. There were no other statistically significant differences in baseline characteristics between treatment groups. Median NIHSS score was 17 (12-21) on arrival and 9 (3-18) at 24 hours. The overall complete recanalization rate was 77.8%. The rate of complete recanalization was not different according to IV tPA administration: TICI >=2b: 79.8% IV tPA patients vs. 75.9% no IV tPA (p=0.065). However, patients who received IV tPA achieved higher any recanalization rate: TICI >=2a: 88.3% vs. 84.2% (RR, 1.0; 95% CI 1.0-1.1; p=0.018). IV tPA was associated with shorter procedural time: 82.4±70.1 min vs. 93.3±74.9 min (p=0.002). There were no differences in SICH: 3.0% vs. 3.2% (p=0.064). No differences were observed in early neurological improvement: 70.1% vs. 71.8% (p=0.491). IV tPA patients achieved higher functional independence: 43.9% vs. 53.3% (RR, 1.2; 95% CI 1.1-1.3; p=0.046), and less mortality: 21.4% vs. 14.7% IVT (RR, 0.7; 95% CI 0.6-0.8; p=0.001).

CONCLUSION

IV tPA before mechanical thrombectomy is associated with better recanalization rate, shorter procedural time, better functional independence, and less mortality. In addition, preceding IV tPA does not seem to influence in SICH development.

CLINICAL RELEVANCE/APPLICATION

Endovascular stroke therapy has revolutionized the management of patients with acute brain infarction. There is a lack of evidence-based data concerning the impact of including IV tPA before mechanical thrombectomy.

SSJ20-02 New Detector with Special High Definition (Hi-Def) Zoom Feature for Neuro Interventional Procedures

Tuesday, Nov. 28 3:10PM - 3:20PM Room: N229

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PURPOSE

Traditional Flat Panel Detectors (FPDs) have increasing difficulty in visualizing improved neuro interventional devices which have more complex finer structures. A new unique single package High Definition detector with a special Hi-Def zoom feature was developed. Initial subjective evaluations of Pipeline Embolization Device (PED) images acquired using the FPD and the Hi-Def zoom of this detector are presented.

METHOD AND MATERIALS

A PED was placed inside a neurovascular phantom with anatomically accurate 3D printed vessel structures embedded in a skull and having PMMA attenuating material. For image quality comparison, PED images were acquired with FPD and Hi-Def zoom in identical Fields-of-View. Ten Image sets each composed of one FPD and one Hi-Def zoom image acquired under the same x-ray exposure conditions were presented together to two blinded-neuro-interventionists who were asked to select the better image of the two and rate the selection as either Similar, Preferred or Much Preferred. Their annotations about the better images were also recorded.

RESULTS

For all the image sets generally, the Hi-Def zoom images were Much Preferred over FPD images by both the raters. Both the raters commented that the visualization of the stent structures in the Hi-Def zoom images were superior compared to those of the FPD and indicated that such imaging can be very helpful during interventions.

CONCLUSION

A new High Definition detector with high resolution Hi-Def zoom was developed and evaluated in simulated clinical settings by neurovascular interventionists. The Hi-Def zoom images were generally Much Preferred due to their superior image quality. Information regarding delicate movements and structural changes of the devices during deployment, navigation of the microwire through the stent, and stent to vessel wall apposition are critical to an intervention's success. The new high resolution imaging can improve real time visualization of such information and could potentially improve endovascular treatment outcomes.

CLINICAL RELEVANCE/APPLICATION

Superior real time imaging of devices during a neuroendovascular intervention treatment of diseases such as strokes and aneurysms is critical to its success and to ensure good treatment outcomes.

SSJ20-03 Intraoperative Thermal Imaging During Awake Craniotomy

Tuesday, Nov. 28 3:20PM - 3:30PM Room: N229

Participants
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PURPOSE

Gliomas represent a diverse and deadly class of brain tumors, for which aggressive surgical resection of the tumor is the best treatment. Resection is limited in a majority of patients by tumor invasion into critical functional regions, which are avoided in resection through direct cortical stimulation mapping during awake craniotomy.. However, this method has poor spatial resolution (~10 mm), limiting the extent of resection and therefore survival.

METHOD AND MATERIALS

Neural activation creates a downstream compensatory vasodilation, increasing local perfusion. Intraoperatively, this mechanism causes a focal increase in cortical temperature, which can be measured by infrared thermal imaging. This approach captures small temperature deviations (>0.03 °C) at high spatial and temporal resolution (~0.5 mm, 30 Hz). In this study, we examine cortical

temperature gradients during a behavioral task to construct a neural activation map for guidance of surgical resection.

RESULTS

Cortical temperature changes were measured in two patients undergoing routine direct cortical stimulation during glioma resection surgery. The first patient performed a lip pursing task, which created diffuse temperature elevation (+0.3 °C) throughout facial motor and sensory regions. The region of maximal temperature elevation (+0.5 °C) coincided with the area of positive direct cortical stimulation. A second patient performed a right hand clenching task, which created temperature elevation (+0.5 °C) in the left motor cortex in the areas of positive direct cortical stimulation. This thermal signature was not observed during left hand clenching, which produced an activation pattern similar to the cortical temperature pattern measured at patient baseline.

CONCLUSION

Intraoperative thermal imaging may delineate activated cortical regions during awake craniotomy, and appears grossly consistent with direct cortical stimulation. While further measurements are necessary to conclude efficacy across tasks and patients, the utility of thermal imaging as an intraoperative mapping tool is promising. Future work will parse networks and functional regions by examining the dynamics of small temperature fluctuations within gross activation.

CLINICAL RELEVANCE/APPLICATION

Infrared thermal imaging is a promising approach for intraoperative cortical mapping, permitting increased extents of resection which can prolong patient survival after glioma resection surgery.

SSJ20-04 Development of Patient-Specific CT/MR "Bio-mimicking" 3D-Printed Phantoms, with Application to Minimally-Invasive Image-Guided Thermal Ablation Planning and Simulation

Tuesday, Nov. 28 3:30PM - 3:40PM Room: N229

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PURPOSE

Image-guided percutaneous ablations in the head/neck, spine, chest, and abdomen have a steep learning curve and safety is a concern as new application sites such as the posterior spinal elements are explored. We developed a technique to 3D print "bio-mimicking" phantoms that replicate the patient-specific anatomy in both CT and MRI, and used it to simulate an image-guided cryoablation

METHOD AND MATERIALS

A model was designed from pre-procedure CT and MRI of a patient w/ L1 left lamina osteoblastoma. Cortical and cancellous bone and osteoblastoma were segmented from the CT. Cerebrospinal fluid, spinal nerves and foraminal fat were segmented from the T1- and T2-W MRI. Tissues segmented from each image set were combined in a single model using cancellous bone, aorta, and diaphragmatic crura as landmarks. The combined model was 3D-printed using a different mixture of 2 MRI-visible and 1 non-MRI-visible material for each tissue, and imaged identical to the patient (120 kVp CT, T1/2W FSE MRI). Signal intensity and contrast-to-noise ratio (CNR) of tissues in patient and model images were compared with ANOVA to determine if tissues separable in vivo were also separable with the printed model. Finally, CT-guided power drilling and subsequent MRI-monitored cryoablation was performed on the model identically to the patient procedure.

CONCLUSION

Bio-mimicking 3D-printed models can be produced that replicate patient anatomy in both CT and MRI. These models enable targeting and monitoring key anatomic structures during CT- and MRI-guided procedures such as thermal ablations.

CLINICAL RELEVANCE/APPLICATION

Patient-specific bio-mimicking 3D printed phantoms are now possible for simulating and hands-on teaching of CT/MR image-guided thermal ablations toward enhancing procedure safety and efficacy.

SSJ20-05 Clinical and Imaging Evaluation of Lumbar Disc Herniation after Different Oxygen-Ozone (O2-O3) Chemiodiscolysis Treatment Sessions: Which is the Best Treatment Protocol Management in Partially-Responder Patients?

Tuesday, Nov. 28 3:40PM - 3:50PM Room: N229

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PURPOSE

To compare the therapeutic outcome of different treatment sessions of oxygen-ozone (O2-O3) therapy in patients with lumbar disc herniation

METHOD AND MATERIALS

We retrospectively evaluated 432 patients (mean age 44.3 years, range 26-69), who underwent multiple treatment sessions of O2-O3 lumbar chemiodiscolysis in the period between January 2014 and January 2017. We excluded patients with multiple level pathology, patients with multiple causes of low back pain, patients who underwent surgery during the follow-up period. For each patient we evaluated the number of treatment sessions and the type of treatment performed. Treatment outcome was assessed using a modified MacNab method to assess the clinical response and performing MRI to evaluate the modifications of the disc herniation area

RESULTS

235 patients were treated with 2 sessions of intradiscal injection associated with periganglionic steroid injection (Group A); 197 patients received an intradiscal-periganglior injection of O2-O3 and a second periganglionic injection with steroids (Group B). The mean time interval between each treatment was 32.6 days (range 15-62). Treatment was successful in terms of clinical outcome in 82.3% of patients of group A and 78.7% in group B. Statistical analysis showed no statistically significant difference between the two groups in terms of both clinical results and reduction of the disc herniation area ($p<=0.001$)

CONCLUSION

Multiple intradiscal ozone injections arenot associated with a superior herniation volume reduction nor better clinical outcome compared to a single intradiscal O2-O3 injection followed by periradicular steroids

CLINICAL RELEVANCE/APPLICATION

According to the results of our follow-up, in partially or non-responder patients after a first O2-O3 intradiscal injection, a better cost-effective protocol should include a second periradicular steroid injection rather that additional intradiscal treatments

SSJ20-06 Efficacy and Safety of Ethanol Ablation for Branchial Cleft Cysts

Tuesday, Nov. 28 3:50PM - 4:00PM Room: N229

Participants
Eun Ju Ha, Suwon, Korea, Republic Of (*Presenter*) Nothing to Disclose
Jung Hwan Baek, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Branchial cleft cyst (BCC) is a common congenital lesion of the neck. This study evaluated the efficacy and safety of ethanol ablation (EA) as an alternative treatment to surgery for BCC.

METHOD AND MATERIALS

Between September 2006 and October 2016, EA was performed in 22 patients who refused surgery for a second BCC. After the exclusion of two patients who were lost to follow-up, the data of 20 patients were retrospectively evaluated. All index masses were confirmed as benign before treatment. Ultrasound-guided aspiration of the cystic fluid was followed by injection of absolute ethanol (99%) into the lesion. The injected volume of ethanol was 50-80% of the volume of fluid aspirated. Therapeutic outcome, including volume reduction ratio (VRR), therapeutic success rate (VRR > 50% and/or no palpable mass), and complications, were evaluated.

RESULTS

The mean index volume of the cysts was 26.4 ± 15.7 mL (range: 3.8-49.9 mL). After ablation, the mean volume of the cysts decreased to 1.2 ± 1.1 mL (range: 0.0-3.5 mL). The mean VRR at last follow-up was 93.9 ± 7.9% (range: 75.5-100.0%, $P < 0.001$). Therapeutic success was achieved in all nodules (20/20; 100%), and the symptomatic ($P < 0.001$) and cosmetic ($P < 0.001$) scores had improved significantly by the last follow-up. In one patient, intracystic hemorrhage was developed during the aspiration; however, no major complications occurred in all patients.

CONCLUSION

EA is an effective and safe treatment for patients with BCC who refuse, or are ineligible for, surgery.

CLINICAL RELEVANCE/APPLICATION

1. This study evaluated the efficacy and safety of EA for the treatment of BCCs, based on the largest number of cases (drawn from two hospitals) reported thus far. 2. A mean volume reduction in the EA-treated BCCs of 93.0%, as well as improvements in clinical symptoms and cosmetic problems. There were no major complications or procedure-related deaths. 3. After a single session, 55.0% of the patients had incompletely resolved clinical problems but they responded well to additional EA, which was effective and safe and had a therapeutic success rate of 100.0%. These results support the use of EA as a first-line treatment for BCC.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSJ21

Physics (Ultrasound)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S403A

PH US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Jaydev K. Dave, PHD, Philadelphia, PA (*Moderator*) Research Grant, Koninklijke Philips NV; Equipment support, Lantheus Medical Imaging, Inc; Equipment support, General Electric Company
Timothy J. Hall, PhD, Madison, WI (*Moderator*) Equipment support, Siemens AG; Technical support, Siemens AG

Sub-Events

SSJ21-01 How to Identify Optimum Incident Acoustic Output for Utilizing Subharmonic Amplitude from Ultrasound Contrast Microbubbles for Pressure Measurements: A Solution for Real-Time Clinical Applications

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S403A

Participants
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Flemming Forsberg, PhD, Philadelphia, PA (*Abstract Co-Author*) Equipment support, Toshiba Medical Systems Corporation; Research Grant, Toshiba Medical Systems Corporation; Equipment support, Siemens AG; In-kind support, General Electric Company; In-kind support, Lantheus Medical Imaging, Inc
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PURPOSE

At optimum incident acoustic output (IAO), subharmonic aided pressure estimation (SHAPE), based on subharmonic signals from microbubbles, is useful for estimating clinical pressures. However, real-time SHAPE application is impeded because the optimum IAO level varies on a case-by-case basis. Purpose of this work was to address this problem by identifying the optimum IAO for SHAPE in real-time.

METHOD AND MATERIALS

The SHAPE algorithm was developed to sequentially step through each available IAO level, extract the subharmonic amplitude, perform a spline fit (subharmonic amplitude vs. IAO), and identify the IAO level with maximum derivative as the optimum IAO. This algorithm was implemented using a customized interface on a SonixTablet scanner (BK Ultrasound, Peabody, MA) using C/C++ and Qt libraries (The Qt Company, Oslo, Norway). In vitro tests were conducted using a closed-loop flow system with activated Definity (Lantheus Medical Imaging, N Billerica, MA, USA; 0.1 mL) mixed in 750 mL isotonic diluent. A pressure catheter (Millar Inc., Houston, TX) provided ambient pressure values. A pulsed Doppler gate was placed within the lumen of the vessel in the flow system, then the SHAPE algorithm was initiated (ftransmit: 5.6 MHz; chirp down transmit pulse in pulse inversion mode). Catheter pressure and subharmonic data were acquired simultaneously at, below and above the optimum IAO level (10secs; n=3), then a linear correlation was performed between the subharmonic and catheter data using Matlab (MathWorks, Natick, MA, USA).

RESULTS

Correlation coefficient values between SHAPE and the pressure catheter data at, below and above the optimum IAO level were -0.73±0.1, -0.55± 0.2, and -0.70±0.1, respectively, confirming best correlation occurring at the identified IAO level. At the optimum IAO, the sensitivity of the subharmonic signal to the ambient pressure was 13.5±1.0 mmHg/dB. Occasionally at relatively higher IAO levels (2.9 MPap-p), correlation coefficients as high as -0.9 were also noted, presumably due to bubble destruction.

CONCLUSION

Identification of optimum IAO (in real-time) for insonating microbubbles to be utilized for SHAPE has been demonstrated; this will pave the way for real-time clinical applications.

CLINICAL RELEVANCE/APPLICATION

Real-time implementation to determine optimum IAO for insonating microbubbles for SHAPE has been demonstrated and verified; this paves the way for real-time SHAPE applications.

SSJ21-02 Contrast-Enhanced Ultrasound Assisted Percutaneous Nephrostomy: A Technique to Increase Success Rate for Patients with Non-dilated Renal Collecting System

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S403A

Participants
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CONCLUSION

CEUS assisted PCN in patients with nondilated renal collecting system is valuable with high technical success rate and acceptable complications.

Background

For percutaneous nephrostomy (PCN), lack of proper guidance system may lead to hazardous results, especial for these patients with nondilated renal collecting systems. The purpose of our study is to report our single-center experience of contrast-enhanced ultrasound (CEUS) assisted PCN for patients with nondilated renal collecting system.

Evaluation

From November 2011 to September 2015, 47 patients(mean age, 51.9±16.2 years; range, 11-80 years) with clinical necessity to urinary drainage, urinary diversion, or provision of access to the collecting system and with nondilated renal collecting system were performed 48 CEUS assisted PCNs. Ultrasound contrast agent was injected through the puncture needle and the drainage catheter to confirm successful PCN. The technical success rate was 100%(47/47, 95%CI: 93.8%, 100%) per patient and 100% (48/48, 95%CI: 94.0%, 100%) per kidney. For each kidney, the mean number of needle passes was 1.4 ± 0.5 (rang, 1-3). The mean duration of the complete procedure was 18.9±4.8 min (range, 8-30 min). The mean dose of contrast-enhanced agent was 12.9 ± 3.2 ml (range, 8-25 ml). No major complication was observed. Only 4 patients (4/47, 8.5%, 95%CI: 2.37%, 20.4%) had minor complications, including perirenal hematoma last 9 days on ultrasound images in 1 and transitant macroscopic hematuria last about 1-2 days in 3.

Discussion

Several modalities are considered to assist PCN in a nondilated collecting system. CEUS is known to have exclusive advantages including real-time scanning, no radiation, and easy operation, which is also recommended for intracavitary administration. Although PCN in the nondilated collecting system is a technical challenging, our results displayed that CEUS assisted PCN showed comparable success rate with conventional PCN placement in patients with dilated collecting systems.

SSJ21-03 Comparison of Computerized Analysis for Uniformity Assessment in Ultrasound QA

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S403A

Participants
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CONCLUSION

The MBCA method with the mean image shows good sensitivity for UA compared to UiQ, although this is a limited cohort of data available. We will enlarge our sample pool by acquiring cine loops routinely to facilitate this analysis for all probes.

Background

Performing uniformity assessment (UA) and detecting transducer defects of concern is an important component of Ultrasound QA testing. Although visual inspections of acquired phantom images are most frequently done, there is an increasing trend toward computerized analysis of cine files acquired during QC. It is important to understand performance differences between various computerized analysis methods for UA.

Evaluation

We developed a Matlab-based computerized analysis (MBCA) program for UA. It creates a mean image of frames in a cine loop acquired while a transducer is translated over a phantom. Element dropout defects are recognized as "shadows" emanating from the transducer surface. The code calculates a defect cutoff threshold (DCT) based on 3 standard deviations below the data's mean or 3 Median absolute deviations (MAD) below the data's median by utilizing only the ring-down portion of the phantom images. The detection performance was compared with that of a commercial program, UltraiQ(UiQ) that analyzes image data from a ROI having a 12 mm axial extent in the gray scale image. The comparisons were done for linear array transducers (LTA) and GE Logiq scanners evaluated during annual tests during the past year. Nine probes were judged defective, and three of these had recorded cine loops. Seven defects had been visually identified in this data set. Using the cutoff threshold described, the MBCA program applied to the mean image detected all 7 dropout areas (visually identified) from the 3 transducers with no false positive detection. On the other hand, the UiQ only detected four of the dropout areas with three false detections.

Discussion

Our MBCA currently works for LTAs but can be modified to analyze curvilinear arrays. The improved performance over UiQ can be related to a high signal to noise ratio in the ring-down part of the image and to the minimal spread of the defect shadow in this area.

SSJ21-04 Freehand 3D Ultrasound Construction via Preoperative MRI Co-Registration for Spine Needle Interventions

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S403A

Participants
Tharindu De Silva, PhD, Baltimore, MD (*Presenter*) Nothing to Disclose
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PURPOSE

Ultrasound (US)-guided spine needle interventions have limited clinical adoption due to confounding visualization of deep bony anatomy. Image registration between previously acquired MRI and real-time US could provide useful anatomical context to accurately guide needles toward target locations. Registration of MRI with an initially acquired, baseline 3D US image facilitates the mapping of anatomy in MRI to intraoperative US imaging space. This work proposes a method to register a 2D US image sequence to MRI and simultaneously construct a MRI-aligned, 3D US volume to be subsequently used for real-time navigation.

METHOD AND MATERIALS

Within the registration framework, US images were simulated from MRI using a US wave propagation model that incorporated reflection, refraction, and attenuation properties. Acoustic impedances were derived from T1-weighted MR values using a non-linear mapping function with relevant values for vertebra, CSF, fat, muscle, and intervertebral disc. Simulated US was compared with each actual US image using normalized cross-correlation metric and optimized using Powell's method to compute the best corresponding slice from MRI. Registered slices were interpolated in a volumetric grid to construct the 3D volume. Experiments were performed by acquiring axial slices of a lumbar puncture phantom using a 2D, linear, 128-element array probe at 5 cm depth. For comparison, 3D US image was constructed by optically tracking the calibrated 2D US probe.

RESULTS

The error between corresponding anatomical distances between US volumes constructed from the two methods (registration vs tracking) was found to be 1.3 ± 1.2 (mean ± std) mm. Registration accuracy measured as the point-based distance between corresponding anatomical locations from MRI and US was 4.5 ± 5.9 (median ± iqr) mm. Deformation due to applied US probe pressure contributed substantially to this error and it will be incorporated to the simulation model in ongoing work to improve accuracy.

CONCLUSION

Registration between actual and simulated US images could provide a useful method to yield MR-aligned 3D US volume for navigation in spine pain procedures.

CLINICAL RELEVANCE/APPLICATION

The proposed method could provide 3D US images registered to MRI to facilitate accurate needle targeting during spine needle interventions.

SSJ21-05 Can Speed of Sound Be Better Than Conventional Elastography for Breast Characterization?

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S403A

Participants
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Corin F. Otesteanu, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare a novel speed of sound (SoS) method and conventional elastography (strain ratio SR and shear wave velocity SWV) in breast with respect to tissue compression and differentiation.

METHOD AND MATERIALS

A healthy volunteer (42 yr) was repeatedly assessed with SoS and SWV at five different compression levels in order to identify non-linearity confounders. The examinations were performed in the cranio-caudal view and retromammillar segment for both non-diseased breasts. Also, five women with biopsy proven lesions (3 invasive ductal carcinoma IDC, 1 fibroadenoma FA, 1 cyst) were tested to identify differences between SoS, SR and SWV. Ultrasound examination was performed with a commercially available ultrasound system (SonixTouch, Ultrasonix, Richmond, Canada). B-mode imaging was used for lesion localization. Hand-held SoS images were generated for lesion characterization. A flat passive plexiglass reflector positioned opposite to a linear probe was used as a timing reference for the ultrasound signals transmitted through the lesions. Synthetic aperture data was acquired and average SoS values across the lesions were measured with an accuracy of <0.7%. Elastography (SWS and SR) was performed with a GE Logiq E9 machine.

RESULTS

Breast compression was 60 to 25 mm. SWV correlates with breast compression (R2>0.5) while SoS does not show a significant correlation (R2<0.2). The average SoS value was 1465 m/s (SD 7 m/s) and the average SWS value 2.5 m/s (SD 0.2 m/s). The SoS increments in the lesions were [cyst = 0.9%, FA = 0.8%, IDC [2.7-3.0%], while for SWS [cyst = 2.5 m/s, FA = 5.4 m/s, IDC = 4.1-3.95%] and SR [cyst = 1.6, FA = 5.0, IDC 2.8]. While all lesions could be correctly classified with a single SoS threshold, both SE and SWS failed to differentiate FA from IDC.

CONCLUSION

Hand-held speed of sound showed less dependency on compression than SWS and a better differentiation in an exemplary population of benign and cancerous lesions. Further studies are needed to confirm its utility.

CLINICAL RELEVANCE/APPLICATION

A hand-held SoS add-on to conventional ultrasound system provides additional information (Bulk Modulus) to conventional elastography (Young Modulus) for multi-parametric tissue characterization. SoS may reduce operator dependency and outperform conventional elastography in selected clinical scenarios. This novel technique can be implemented on a standard ultrasound machine.

SSJ21-06 Acoustic Lens-Based Photoacoustic-Ultrasound System for Noninvasive Thyroid Imaging

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S403A

Participants
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CONCLUSION

A combined non-invasive PA and US imaging system, with functional and structural capability can be a potential alternate for FNAB.

Background

Among thyroid cancer screening techniques, ultrasound (US) is the most widely used modality followed by invasive fine needle aspiration biopsy (FNAB). Approximately 5% of FNAB results are inconclusive and are compromised by insufficient sampling. The US (being a structural imaging method) can depict thyroid cysts and nodules clearly but lacks the ability to differentiate between cancerous and benign nodules. We propose a hybrid multispectral photoacoustic (PA) and ultrasound imaging system for non-invasive. With the combined functional nature of PA imaging capturing physiologic changes and structural image from US image high specificity is expected. This estimate can be depicted as an image that can be used to detect, characterize, diagnose, and monitor suspect lesions in thyroid disease management.

Evaluation

The proposed PA probe consists of a light delivery system, acoustic lens and US transducers that enable real-time frontal plane imaging of the tissue. A fast Fourier-based image formation is considered for volume image formation. Axial and lateral resolution of the probe was evaluated to be 0.3 millimeters (mm) and 1.6 mm. Ex-vivo thyroid studies demonstrated high specificity greater than 96%. A circular scanning stage obtains images from multiple angles using the probe, which improves system signal to noise ratio and a fivefold improvement in lateral resolution. A polyvinylidene fluoride (PVDF) film used as a US source can provide impedance image of the tissue. Adding US imaging to PA will add value co-registering with functional information in locating the nodules.

Discussion

PA absorption image of deoxy and oxyhemoglobin shows a clear distinction between cancerous and benign. The ex-vivo studies suggest that thyroid disease classification accuracy was comparable to that of FNAB. Characterization of the proposed prototype in phantoms with human thyroid geometry are in progress. With multiple view of the target tissue a minimum detectable cancer region of 0.3 mm with high specificity is expected.

SSJ22

Physics (CT: Radiation Dose I)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S403B

CT PH SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Moderator*) Institutional research agreement, Siemens AG; ; ; ; ;
Lifeng Yu, PhD, Chicago, IL (*Moderator*) Nothing to Disclose

Sub-Events

SSJ22-01 Examining the Effects of Lung and Breast Dose CT Scans Using an Organ-Based Tube Current Modulation

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S403B

Participants
Anthony Hardy, BS, Los Angeles, CA (*Presenter*) Nothing to Disclose
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Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Abstract Co-Author*) Institutional research agreement, Siemens AG; ; ; ; ;

PURPOSE

The purpose of this work was to use Monte Carlo simulation techniques to examine the effects of chest CT scans performed with an organ-based tube current modulation (OBM) scheme on lung and breast doses.

METHOD AND MATERIALS

Image and raw projection data were collected for twenty-three patients (14 males, 9 females) undergoing CT chest examinations under IRB approval. These scans actually used a combination of organ based and attenuation-based modulation (XCARE + CAREDose4D, Siemens Healthineers, Forchheim, Germany). From the image data, voxelized models of chest anatomy were generated for use in a previously validated Monte Carlo (MC) simulation code; lung and glandular breast tissues were segmented from patient image data and specifically identified for the simulation. Estimates of lung and breast dose were obtained using an MDCT source model with the tube current modulation values extracted from the raw projection data. These contain precise information about the tube current values as a function of angle and table location. Lung and breast doses were tallied and normalized by scan-specific 32cm CTDIvol values based upon the average tube current across the entire scan length. Water equivalent (Dw) was used as the size metric and was calculated at the center of the scan volume for each patient. These normalized doses were then compared with previously developed estimates of breast and organ dose based on attenuation based modulation only (CAREDose4D).

RESULTS

For normalized lung dose, six patients experienced dose reduction to the lungs, while ten patients experienced an increase to breast dose, with greatest reduction being 50% and greatest increase being 114% relative to CAREDose4D chest protocol. For normalized breast dose, four patients experienced dose reduction to the breast while five patients experienced an increase to breast dose, with greatest reduction being 40% and greatest increase being 55% relative to CAREDose4D chest protocol.

CONCLUSION

The combination of organ based and attenuation based modulation may, at times, increase both lung dose and breast dose in some patients. This may be dependent on the location of the glandular breast tissue relative among other factors.

CLINICAL RELEVANCE/APPLICATION

Organ and attenuation based tube current modulation does reduce breast dose, but some patients may receive substantial dose reduction from attenuation based modulation alone.

SSJ22-02 Radiation Dose Reduction in Thin-Slice Chest CT at a Micro-Dose (mD) Level by Means of 3D Deep Neural Network Convolution (NNC)

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S403B

Participants
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Kenji Suzuki, PhD, Chicago, IL (*Abstract Co-Author*) Royalties, General Electric Company; Royalties, Hologic, Inc; Royalties, MEDIAN Technologies; Royalties, Riverain Technologies; Royalties, Toshiba Medical Systems Corporation; Royalties, Mitsubishi Corporation; Royalties, AlgoMedica, Inc.; ; ; ; ; ; ; ;

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PURPOSE

Radiation dose reduction in chest CT is highly demanded since current radiation dose is still very high for screening. Our purpose was to develop a deep-learning NNC technique to convert thin-slice mDCT to higher-dose (HD) CT volumes where noise and artifacts are significantly reduced.

METHOD AND MATERIALS

We developed a mixture of expert anatomy-specific (AS) NNC models employing volume-based neural network regression in a convolutional manner to convert thin-slice (0.5 mm) mDCT to HD-like CT volumes. We trained 3 AS NNC models with soft-gating layers with 3 anatomic areas in input lower-dose CT (10 mAs, 120 kVp, 0.37 mSv) volumes and those in "teaching" HDCT (550 mAs, 120 kVp, 34.9 mSv) volumes of an anthropomorphic chest phantom (Kyoto Kagaku, Kyoto, Japan). Through training, our NNC learned to convert lower-dose CT to volumes that look like HDCT, where noise and artifact are substantially reduced; thus, term "virtual" HD (VHD) CT. Once trained, our technology no longer requires HDCT. To determine a dose reduction rate, we acquired 5 more studies of the same phantom at different radiation doses (0.74, 1.49, 2.97, 6.21, and 10.68 mSv) by changing tube currents. Structural SIMilarity (SSIM) index was used to evaluate the image quality. For testing, we collected mD (120 kVp, 5 mAs, 0.2 mSv) and full-dose (120 kVp, 50 mAs, 2.0 mSv) thin-slice CT volumes of 50 clinical cases including 30 cases with nodules (Aquilion One, Toshiba, Japan).

RESULTS

Our VHD technology converted lower-dose CT of the testing phantom to VHDCT, improving (t-test; $P<.05$) image quality from SSIM of 0.15 to 0.77 (equivalent to 14.0 mSv), achieving 97.4% dose reduction. With our technology, the contrast-to-noise-ratio (CNR) of mDCT of clinical cases was improved from 4.1±3.9 dB to 21.5±4.9 dB which was also higher (t-test; $P<.05$) than that of "gold-standard" full-dose CT volumes (CNR: 13.4±5.1 dB). Our NNC reduced the noise and artifacts substantially while preserving anatomic structures and pathologies.

CONCLUSION

Our NNC converted thin-slice mDCT volumes of 50 clinical cases to VHDCT volumes that have higher image quality (in terms of CNR) than "gold-standard" full-dose CT volumes, achieving 90% dose reduction. Our phantom study demonstrated up to 97% dose reduction.

CLINICAL RELEVANCE/APPLICATION

Substantial reduction in radiation dose in CT by our VHD technology would potentially make micro-dose CT screening possible, and it would be beneficial to screening population.

SSJ22-03 Estimating Organ Dose from Low Dose Lung Cancer Screening CT Exams Performed with Tube Current Modulation

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S403B

Awards
Trainee Research Prize - Resident

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Christopher H. Cagnon, PhD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Abstract Co-Author*) Institutional research agreement, Siemens AG; ; ; ; ;

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PURPOSE

The purpose of this work was to estimate organ doses from a low-dose lung cancer screening CT exam using tube current modulation (TCM) and patient models of various sizes

METHOD AND MATERIALS

Monte Carlo simulation methods were used to estimate organ doses from a low-dose lung cancer CT screening protocol for a 64-slice CT (Definition AS64, Siemens Healthineers, Germany) that used TCM. Scanning parameters were from the AAPM's Alliance for Quality CT protocols. Data from 26 patients (14 female, 12 male) were obtained under IRB approval. For each patient, both the image data as well as the raw projection data (which contains details of the tube current modulation) were collected. Voxelized patient models were created from the image data reconstructed to full 500 mm Field of View that also had all lung, and for females the glandular breast tissue, identified. Data from the actual TCM schemes were extracted from the raw data and incorporated into the Monte Carlo simulation. The water equivalent diameter (WED) was determined by estimating the attenuation at the center of the scan volume for each patient model. Monte Carlo simulations were performed using the unique TCM scheme for each patient model. Organ doses were tallied and all dose values were normalized by both CTDIvol (32 cm phantom) and DLP for each patient. Absolute and normalized doses were reported as a function of WED for each patient model.

RESULTS

Water equivalent diameters (WED) ranged from 17.4 to 34.2 cm for the females and 14.4 to 24.5 cm for the males. CTDIvol (32 cm phantom) values ranged from 1.37 to 6.0 mGy for females and 1.25 to 2.85 for males. Monte Carlo esimated lung doses ranged from 1.03 to 4.11 mGy for females and 0.91 to 1.88 mGy for males; female breast doses ranged from 0.77 to 6.67 mGy. There is a

relationship between lung dose and WED that also indicates some difference between males (R^2= .77) and females (R^2=0.53). Breast dose also appears to have a relationship to WED (R^2 value 0.7)

CONCLUSION

This work demonstrates the ability to estimate breast and lung doses from a lung cancer screening CT exam using tube current modulation (TCM). The relationship between lung dose and patient size appears to be slightly different between males and females and warrants further investigation.

CLINICAL RELEVANCE/APPLICATION

This work describes investigations to estimate lung and breast dose from lung cancer screening CT exams that use tube current modulation.

SSJ22-04 Comparison of Four SSDE Calculation Approaches in Thoracoabdominal CT

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S403B

Participants
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PURPOSE

To evaluate SSDE (Size Specific Dose Estimate) calculations relative to a method recommended in the AAPM Report 220 using thoracoabdominal CT examinations.

METHOD AND MATERIALS

SSDE values of 112 adult thoracoabdominal exams (50 male, 62 female, BMI-range 15.8 to 39.9 kg/m2) from three CT scanners (Siemens Somatom Definition AS+, Flash and Edge) were evaluated using four calculation methods. First, the study's reference was calculated from reconstructed axial images according to the AAPM Report 220. A dedicated reconstruction with non-overlapping slices and a 500 mm field of view was used. Slice by slice, the water-equivalent diameter (WED) was calculated excluding the patient table, the CTDIvol was extracted and the SSDE was determined. The average over all slices was used as the reference SSDE. Secondly, the WED of only one slice at the center of the scan region was calculated and the SSDE was obtained using the mean CTDIvol. The third and fourth SSDE results were extracted from two commercial dose monitoring software tools (Radimetrics, Bayer HealthCare and teamplay Dose, Siemens Healthineers). The results from the dose monitoring software tools were obtained from the localizer radiographs.

RESULTS

Compared to the reference method, on average the SSDE values from the central slice method were 4% lower and the SSDE values from Radimetrics were 5% lower (1% higher) before (after) optimization of the scan region to phantom mapping in the software. The SSDE values from teamplay were 9% lower (1% higher) on average compared to the reference method before (after) optimization of scan region.

CONCLUSION

AAPM Report 220 proposes that an SSDE calculation method is compliant with a reference method if the root mean square deviation is less than 10 % relative to the reference. According to this criterion, the central slice method and the optimized teamplay and Radimetrics methods agree with the reference method.

CLINICAL RELEVANCE/APPLICATION

As standardized SSDE calculations are not yet readily available from CT scanners, comparisons of available options are needed to choose appropriate methods for accurate patient dose estimates.

SSJ22-05 Equipment Selection: Comparison of Four Different Dose Monitoring Commercial Systems - How the Choice of Different Calculation Methods Could Affect the SSDE in CT Scans of Different Body Areas

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S403B

Participants
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PURPOSE

The dose from a CT scan depends on both patient size and scanner radiation output. Size-specific dose estimate (SSDE) is calculated applying a correction factor based on patient's size to the CTDI value. The purpose of the study was to evaluate SSDE calculation accuracy of four different commercial Radiation Dose Index Monitoring (RDIM) software.

METHOD AND MATERIALS

Two sets of CT acquisitions (GE Discovery HD750), with and without Automatic Tube Current Modulation (ATCM), were performed on an anthropomorphic phantom positioned at the center of the scanning Field-of-View (FOV). Acquisitions were repeated after increasing or decreasing table height by 5 cm. Each set consisted of 6 acquisitions of different scanning length: chest (C) , adbomen (A), neck (N), chest+abdomen (C+A), neck+chest (N+C), head+neck+chest+abdomen (H+N+C+A). A user-developed code (Matlab, Matworks) was applied to calculate Size Specific Dose Estimate (SSDE) from Water Equivalent Diameter (WED) or Effective Diameter (eff), using the image at the center of the scanning region (SSDEc) or the average on all the axial images (SSDEm).Calculated values were compared with those registered by four commercial Radiation Dose Index Monitoring System: Radimetrics, DoseWatch, NexoDose and RDM.

RESULTS

The difference between SSDEm,WED vs SSDEm,eff and SSDEc,WED vs SSDEc,eff were within 5 % on all the scans (RMS=3.17%, max=5.1%). The difference between SSDEm,WED vs SSDEc,WED and SSDEm,eff vs SSDEc,eff were within 7 % on scan C, A and C+A (RMS=5.6%, max=9.2%) and increased on scan H+N+C+A, N and N+C (RMS=17.5%, max=31.2%) due to the diameter variation within the scanning length. The maximum difference between SSDE registered on the RDIM software was lower in C, A and C+A (RMS=15.2%, max=29.4%) and became relevant on scan H+N+C+A, N and N+C A (RMS=37.4%, max=51.7%).

CONCLUSION

Different methods of SSDE calculation are implemented by different RDIM vendor. Relevant differences were found when the scanning region comprehend anatomy with a high variation of patient attenuation (eg neck+shoulder). When comparing result from different evaluation software, the user should be aware of the calculation methods implemented and their limitation.

CLINICAL RELEVANCE/APPLICATION

Differences in SSDE arising from different calculation methods implemented on commercial dose monitoring systems should be carefully considered when comparing data in a multi-institutional framework.

SSJ22-06 Comparison of Clinical and Phantom Image Quality for Low Contrast Liver Lesions in a Prospective Multicenter CT scanner Dose Optimization Program

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S403B

Participants
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PURPOSE

To compare diagnostic performance for low contrast liver lesions on patient and phantom images, in a prospective multicenter CT scanner dose optimization program.

METHOD AND MATERIALS

A CT scanner protocol harmonization process based on clinical indication and BMI (<25 / >25), followed by a 12% stepwise dose reduction program, was implemented in a multicenter medical imaging group (5 units, Philips Healthcare, NL). During the optimization phase, 3035 abdomen CT examinations were prospectively assessed by experienced radiologists with a "positive/negative" diagnostic image quality electronic voting tool and 33 patients who underwent a CT examination for liver tumor or cancer staging before and after optimization were graded for image quality using European image quality guidelines. In parallel, phantom (QRM™ 401 abdomen, Germany) acquisition with 2.5 (size M) and 5cm (size L) fat ring was also performed before and after dose reduction using the liver tumor follow-up protocol. A channelized hotelling model observer was used to assess the lesion detectability using the ROC paradigm with the area under the ROC curve (AUC) as figure of merit.

RESULTS

Median patient CTDIvol value decreased from 6.8 to 5.2mGy (-24%, p<0.005) and from 10.8 to 8.5mGy (-22%, p<0.005) respectively for BMI<25 and >25. For phantom images, mean CTDIvol value decreased from 8.8 to 6.3mGy (-28%) for M-sized and from 15.9 to 11.8mGy (-26%) for L-sized phantom. No negative vote for diagnostic image quality was registered and preliminary results on 33 paired patients showed no loss of image quality according to European image guidelines. Image quality phantom analysis showed a constant low contrast lesion detectability, even after a 26% dose reduction. However, an additional 12% dose reduction started impairing the detectability of 5mm lesions.

CONCLUSION

Combining clinical diagnostic image quality and phantom based analysis enable dose reduction according to the ALARA principle without impairing low contrast liver lesion detectability.

CLINICAL RELEVANCE/APPLICATION

Combining clinical image quality evaluation and phantom analysis for image quality optimization preserves diagnostic confidence and sets a low-level threshold enabling no loss of detectability of low contrast liver lesions.

SSJ23

Physics (Nuclear Medicine)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404AB

NM PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSJ23-01 MR-Assisted PET Reconstruction in the Presence of Respiratory Motion: A Phantom Study

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S404AB

Participants
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PURPOSE

The simultaneous PET/MR provides an unprecedented opportunity for motion correction. We aimed at developing an integrated MR-assisted PET motion correction method which would allow accurate PET quantification in the presence of respiratory motion. This makes it possible to detect small lesions, which would otherwise become undetectable given the blurring caused by motion. In this study, we also evaluated the performance of the proposed method using a deformable motion phantom with known ground truth.

METHOD AND MATERIALS

For tracking respiratory motion, we developed a self-navigated free breathing MR motion correction method that provides robust and fully-automated respiratory motion detection. Four spheres with FDG activity were placed in a deformable motion phantom to mimic FDG avid lesions. The diameters of the spheres were 4.5 mm, 6.75 mm, 7.5 mm and 9 mm, respectively. List mode PET data and MR motion correction data were acquired simultaneously in the presence and absence of motion. Respiratory motion was first detected using the self-navigated free breathing MR method. This MR derived motion was then used to rebin the simultaneously acquired list mode PET data. Motion-corrected and uncorrected PET images were reconstructed using the same motion-corrupted data. On the other hand, the static (no-motion) PET/MR scan was used as the ground truth for PET activity.

RESULTS

In reference to the static PET, the relative FDG activity measured in the motion uncorrected PET images were 55% (D=4.5 mm, motion range = 9.8 mm), 61% (D=6.75 mm, motion range = 10.7 mm), 75% (D=7.5 mm, motion range = 7.1 mm) and 69% (D=9 mm, motion range = 9.2 mm) for the four spheres. In contrast, the measured activity became, respectively, 95%, 99%, 96% and 96% after applying the MR assisted PET motion correction.

CONCLUSION

Depending on the size and the magnitude of motion, motion-compromised PET images can show up to 45% reduction in FDG activity. Our MR-assisted PET motion correction can recover the activity back to 95%-99% of that measured using the static data set.

CLINICAL RELEVANCE/APPLICATION

High noise and respiratory motion makes it difficult to detect small lesions in PET images. MR-assisted motion correction makes it possible to delineate lesions with significantly higher accuracy.

SSJ23-02 Faster PET Imaging: Evaluation and Optimization of PET Acquisition Overlap on both Solid State Digital PET and PMT PET in FDG and NaF PET/CT

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S404AB

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PURPOSE

To improve patient comfort and clinical volume throughput by accelerating PET imaging using optimized PET acquisition overlaps going beyond current accepted boundaries in FDG and NaF TOF PET on both solid state digital photon counting PET (dPET) and conventional PMT PET (cPET).

METHOD AND MATERIALS

An ongoing pre-clinical (beagles) and clinical trial was initiated to investigate the feasibility of minimizing and optimizing PET acquisition overlap in axial on cPET (Gemini TF 64) and dPET (Vereos TF). Four groups of wholebody PET/CT are included: A. preclinical FDG PET (~2.8mCi), B. preclinical NaF PET (~2.8mCi), C. clinical FDG PET (~13mCi) and D. clinical research NaF PET (~3mCi). Intra-individual PET imaging was acquired on both systems under investigational overlaps of 27%, 20%, 12% and 0% besides system defaults (Gemini: 53%; Vereos: 39%). Uniformity phantoms were performed for validation. PET image quality (IQ) and SUV assessment were blinded reviewed by multiple readers.

RESULTS

4 beagles (2 FDG and 2 NaF) and 4 human subjects (2 FDG and 2 NaF) were imaged. dPET images consistently showed better IQ with enhanced contrast and more uniform background than cPET under various overlaps. FDG PET exams showed no impact on visual grades with overlaps of 27%+ for cPET and 20%+ for dPET, compared to PET using default overlaps. NaF PET exams revealed better acceptable range than FDG PET with 20%+ for cPET, and 12%+ for dPET (surprisingly, nice NaF dPET images obtained even without overlap). Reducing overlap to 27% for cPET and to 20% for dPET from default saved ~40% acq time. No significant SUV variances were found between PET using minimized overlaps and default PET for cerebellum, lung, heart, aorta, liver, fat, muscle, bone marrow, thighs and target lesions ($p>0.05$), except kidneys and bladder.

CONCLUSION

The study demonstrated through combined pre-clinical, phantom and clinical exams the feasibility of reducing PET overlaps on both solid state PET and PMT PET scanners to accelerate PET imaging for ~40% from current levels without degradation of image quality. Advantages of solid state PET being capable of enabling faster PET using less PET overlaps than PMT PET was obtained.

CLINICAL RELEVANCE/APPLICATION

Faster PET imaging has substential benifits to patient comfort and clinical volume throughput and the study examed such by optimizing PET acquisition overlaps in FDG and NaF PET on both solid state PET and PMT PET systems.

SSJ23-03 Ultra High Spatial and Energy Resolution PET Detector

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S404AB

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PURPOSE

Current Positron Emission Tomography (PET) scanners have a limited image resolution which is due both to the intrinsic limits set by PET physics and the design and the material used in state-of-the-art PET scanners. We present a novel 3D gamma sensor, based on pixelated CdTe, to reduce significantly the limitations coming from spatial and energy resolution.

METHOD AND MATERIALS

Each detector module has 4000 voxels (independent channels). Each voxel consists of 1mm x 1mm x 2mm of CdTe bonded to a dedicate pixel channel. The detector module is made of a stack of 10 layers. Each layer has 4 sensors glued to a flex printed circuit board (PCB). The sensor itself is a hybrid pixel CdTe detector, of size 10 mm x 10 mm x 2 mm, bonded to a dedicated pixel ASIC. The pixel ASIC is thinned down to 200um and the flex PCB is 255 um thick. Effectively, each layer has a thickness of 2mm of active material (CdTe), and 0.35mm of passive material. Each detector module has an amount of CdTe equal to 20 mm x 20 mm x 20 mm. A total of 18 of such detector modules will form a PET ring with an inner radius of 6.5 cm and an axial FOV of 2.6 cm. The full ring has 72000 independent channels. Each ASIC (of 100 channels) has one TDC with a time resolution of 1 nano-second. Each channel has its own pre-amp, shaper, discriminator, and 11 bit ADC. Each triggered voxel sends its digitized energy signal plus a time stamp. Currently, 11 out of the 18 detector modules have been assembled and tested using a Na22 source with a bias voltage of 250V/mm.

RESULTS

Overall 90% of the channels are operational. The other 10% have defects due to electronics or detector leakage current. With these working conditions, the energy resolution obtained for PET events is 2.4% at FWHM. The energy resolution for Compton events, reconstructed from two different sensors, is 3.4% at FWHM.

CONCLUSION

With a full PET ring and operating the CdTe at 500V/mm, we expect to achieve the intrinsic spatial resolution set by physics

With a full PET ring and operating the CdTe at 300V/mm, we expect to achieve the intrinsic spatial resolution set by physics, thanks to the excellent 3D detector granularity and with a negligible scattered fraction (4%) thanks to the excellent energy resolution. This translates into a possible detection of cancer lesions as small as 2mm in diameter.

CLINICAL RELEVANCE/APPLICATION

This novel PET make it possible to detector cancer lesion as small as 2mm in diameter with TNR 4:1

SSJ23-04 Evaluation of CZT Gamma Cameras for Whole-Body SPECT and Small FOV Imaging

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S404AB

Participants
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CONCLUSION

Continual improvements in CZT detector arrays for molecular imaging, coupled with optimal collimator and image reconstruction, result in minimized dose and exam time. With CZT cost and performance improving, more clinical applications are expected.

Background

The semiconductor CdZnTe (CZT) direct-conversion gamma photon detector has been used in several molecular imaging applications, including small-animal and whole-body human SPECT, cardiac SPECT, and molecular breast imaging (MBI). We designed a modular gamma detector (4.4 cm square with 2 mm pixel pitch) and tiled it in two array sizes: a small FOV camera (8.8 cm square, 44 x 44 pixels) and a whole-body SPECT camera (39.6 cm x 52.8 cm, 198 x 264 pixels) that we mounted on a refurbished SPECT gantry for demonstration. We evaluated the performance of these gamma cameras.

Evaluation

Integration of pixelated CZT detectors with advanced ASICs and readout electronics improves system performance. We measured energy resolution of 3.0% FWHM at 140 keV, intrinsic flood field uniformity of ±0.8% integral and ±0.4% differential, system spatial resolution at 10 cm with an LEHR collimator of 6.8 mm and 7.5 mm without and with scatter, and intrinsic detector count rate performance of 1.4 M cps at 20% loss and 6.1M cps maximum observed. These metrics are significantly better than scintillator SPECT systems.

Discussion

Very good energy resolution enables better scatter rejection and image contrast, further enhanced by excellent uniformity. Smaller pixels improve partial-volume dilution and quantitation. Spatial resolution is improved, even with hexagonal-hole collimators, but registered square-hole collimators provide significantly better resolution and a boost of about 30% in sensitivity which can lower dose and/or exam time. The non-paralyzable CZT cameras count at much higher count rates, enabling new first-pass and pharmacokinetic studies. Advances in detectors, collimators, and image reconstruction have significantly improved efficiency of CZT-based molecular imaging systems and the cost of CZT detectors has steadily declined.

SSJ23-05 TV-Constrained Image Reconstruction from List-Mode TOF-PET Data

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S404AB

Participants
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PURPOSE

We investigate an innovative image reconstruction for advanced digital time-of-flight (TOF) positron-emission tomography (PET) and demonstrate its potential for improving image quality in digital TOF PET, in terms of enhanced spatial resolution, signal-to-noise ratio, and axial coverage.

METHOD AND MATERIALS

We employ a digital SiMP TOF PET clinical scanner to collect list-mode TOF-PET data from the Jaszczak and IEC phantoms. The Jaszczak phantom contains six types of cylindrical-shaped cold rods of diameters 4.8, 6.4, 7.9, 9.5, 11.1, and 12.7 mm, whereas the IEC phantom includes 6 spheres of 10, 13, 17, 22, 28, and 37 mm diameter. The activity in the four smallest spheres is 4 times of the background, and the other two spheres have zero concentration. We developed an iterative algorithm based on Chambolle-Pock framework to reconstruct images. Images reconstructed by use of the standard ordered-subset-expectation-maximization (OSEM) algorithm are used as references. Reconstructions are evaluated visually and quantitatively. In particular, the IEC-phantom reconstructions are assessed following the instruction in NEMA NU 2-2012.

RESULTS

TOF-PET images reconstructed with the proposed algorithm exhibit appreciably lower background noise and enhanced contrast relative to that of the reference images. In particular, the reconstructions are with much improved image quality especially in regions near the axial edges where the reference images are observed to have significant artifacts. For the Jaszczak phantom, the smallest revealed cold rods reconstructed by the proposed algorithm are of 7.9mm diameter, whereas those are of 12.7 mm in the reference image. This underscores a considerable improvement on the spatial resolution in reconstructed images. For the IEC phantom, the reconstructions with the proposed algorithm reveal 7%~20% increased contrast for hot spheres, 4%~6% increased contrast for cold spheres, and 27%~46% decreased noise for background over that of the references.

CONCLUSION

The novel algorithm proposed can yield reconstructions from TOF-PET data with considerably improved spatial and contrast resolution and signal-to-noise ratio over the standard algorithms in TOF-PET imaging.

CLINICAL RELEVANCE/APPLICATION

The PET-image quality may be improved by use of advanced algorithms. The algorithm-enabled quality improvement may be of clinical implication for enhanced lesion detectability at low count statistics.

SSJ23-06 Deep Learning Enables at Least 100-fold Dose Reduction for PET Imaging

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S404AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Lowering injected dose in PET can reduce the risk to patients, lower imaging costs and potentially improve imaging efficiency. In addition, it may help imaging logistics when fast-decaying tracers are used. However, lowered dose adversely affects PET image quality. Previous methods typically use complicated and slow iterative reconstruction, yet still cannot yield satisfactory results at significantly low dose.

METHOD AND MATERIALS

We developed a deep network(convolutional encoder-decoder residual network) to recover PET images acquired at ultra-low-dose. This network conducts patch-to-patch regression tasks, taking a noisy low-dose PET image patch as input and outputting a high-quality patch to approximate the corresponding patch in full-dose PET. The final reconstruction is generated by concatenating and averaging overlapping patches. Using bypass connections and patch-based training, we reduced the regression task complexity and achieved robust training performance. To avoid over-fitting, we trained the network with data augmentations(~10000patches×2flips×4rotations). Brain PET-MR datasets(GE Signa 3T) were collected from 7 patients with recurrent glioblastoma(65±6 yrs, 4 males), who received 10mCi FDG. We used the full-dose reconstruction(3D-OSEM, 2 iterations and 28 subsets) as gold-standard. For input, we created low-dose images by removing counts from the listmode data, reconstructing with various dose-reduction factors(DRF). We tested on DRFs up to 200-fold, showing we can acheive satisfactory results at least with 100-fold (1% of original counts).

RESULTS

To show the method can generalize on different data/subjects, we trained the model on subsets of slices from 3 patients and evaluated on all slices which were not used for training from all 7 patients. The proposed method reduces over 50% Root-Mean-Square-Error(RMSE) and gains 7dB in Peak-Signal-Noise-Ratio(PSNR) compared with the conventional method and achieves similar Contrast-Noise-Ratio(CNR) as the gold-standard.

CONCLUSION

Using a deep learning algorithm, we can reconstruct ultra-low-dose (at least 100 fold) PET images and achieve comparable image quality as the full-dose images.

CLINICAL RELEVANCE/APPLICATION

This method could dramatically reduce the radiation dose in PET imaging: a 100-fold-low-dose reduces the effective radiation in PET imaging to a similar level as a NYC-LA flight.

SSJ24

Radiation Oncology (Gastrointestinal)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S104A

GI RO OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSJ24-01 Baseline Hepatobiliary Iminodiacetic Acid (HIDA) Scans May Predict Toxicity after Stereotactic Body Radiation Therapy (SBRT)

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S104A

Awards
Student Travel Stipend Award

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PURPOSE

Cirrhotic patients (pts) may have regional variations in liver function (LF) that cannot be quantified by clinical scores based on serum liver function testing (LFT). Hepatobiliary iminodiacetic acid (SPECT-HIDA) scans map regional variations in LF. We aim to correlate HIDA with standard LFT and to evaluate its ability to predict toxicity.

METHOD AND MATERIALS

The study included pts with hepatocellular carcinoma who had a baseline SPECT-HIDA between 12/1/2012-2/28/2017. LFTs were collected at baseline, 3, and 6 months after treatment. Child-Turcotte-Pugh (CTP) and modified end-stage liver disease (MELD) scores were calculated. Pearson correlation was used to correlate HIDA and LFT. Toxicity was defined as an increase in MELD > median at 3 and 6 months (>2-point change). Stereotactic Body Radiation Therapy (SBRT) pts were analyzed separately to evaluate whether functional residual capacity (FRC HIDA; calculated as % counts receiving <15Gy * global HIDA score) predicted toxicity.

RESULTS

32 pts met inclusion criteria (SBRT=17, liver directed therapy=5, surgery=4, no therapy=6). Global HIDA correlated with CTP (r=-0.662, p=<0.001) and MELD (r=-0.690, p=<0.001) scores. Mean global HIDA was higher in CTPA than CTPB pts (3.6 vs 1.8 %/min/body surface area (BSA); p=<0.001). Mean HIDA for pts with MELD <=9 was higher than those with MELD >=10 (3.7 vs 2.0%/min/BSA; p=0.001). There was no difference in mean baseline HIDA between pts without and those with toxicity. SBRT pts without toxicity at 3 months had a higher mean global HIDA than those with toxicity (3.6 vs 2.2 %/min/BSA, p=0.025). Mean FRC HIDA in pts without toxicity at 3 months was higher than those with toxicity (2.8 vs 1.8 %/min/BSA, p=0.022). Similar trends were observed at 6 months. Of note, 8/17 SBRT pts had peritumoral defects in regional LF on baseline HIDA.

CONCLUSION

Global HIDA correlated with standard cirrhosis scoring systems. In SBRT pts, lower baseline global HIDA and FRC HIDA were associated with toxicity. If validated by a larger sample size, FRC HIDA and mapping regional variations in LF may help guide personalized SBRT.

CLINICAL RELEVANCE/APPLICATION

Global HIDA value correlates with standard cirrhosis scoring systems. If validated by a larger sample size, FRC HIDA and mapping regional LF may predict toxicity and guide personalized SBRT.

SSJ24-02 The Clinical Outcome of Stereotactic Ablative Radiotherapy for Advanced Hepatocellular Carcinoma: A Multicenter Retrospective Study

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S104A

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ABSTRACT

Purpose/Objective(s): To investigate the clinical outcome in patients with advanced hepatocellular carcinoma (HCC) treated with stereotactic ablative radiotherapy (SABR).Materials/Methods: Between July 2006 and June 2016, we retrospectively reviewed medical records of patients with advanced HCC treated by SABR at two medical centers. The patient eligibility criteria are as follows: (1) histologically or radiologically confirmed HCC according to AASLD (American Association for Study of Liver Diseases) criteria; (2) Karnofsky performance score =2; (3) Child-Pugh score of 5-7; and (4) Normal liver volume more than 700 mL. The treatment response was evaluated by follow-up imaging study according to RECIST (V1.1) criteria and treatment-related toxicities were scored by CTCAE (V4.03).Results: A total of 32 patients with a median Child-Pugh score of 5 (range: 5-7) were enrolled. Ten (31%) patients had tumor vascular thrombosis. The mean tumor size and mean GTV volume were 4.1 cm (range: 2.1-6.0 cm) and 22.0 mL (range: 4.5-54.3 mL), respectively. The dose scheme of SABR ranged from 24-54 Gy in 3-6 fractions (median: 45 Gy in 5 fractions). With a median follow-up duration of 13 months, the overall best treatment response rate was 46% and the median time to progression was 12 months. The 1-year local control and 1-year overall survival rate were 93% and 74%, respectively. No treatment-related toxicities above grade 2 were observed.Conclusion: SABR provides good local control and tolerable toxicity for selected patients with advanced HCC. Future prospective study is warranted to clarify the optimal patient selection, SABR dose scheme and combination of systemic drugs.

SSJ24-03 Robotic Stereotactic Body Radiation Therapy (SBRT) for Liver Metastases at a Non-Academic, Community-Based Hospital

Tuesday, Nov. 28 3:20PM - 3:30PM Room: S104A

Participants
Emily Anstadt, West Hartford, CT (*Presenter*) Nothing to Disclose
Richard C. Shumway, MD, Hartford, CT (*Abstract Co-Author*) Nothing to Disclose
Joseph M. Colasanto, MD, Torrington, CT (*Abstract Co-Author*) Nothing to Disclose
David Grew, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Stereotactic body radiation therapy (SBRT) has been shown to be a safe and effective option for treatment of liver metastases in both retrospective and phase I/II prospective studies. However, existing data are mostly reported by academic centers. There have been reports that advanced radiotherapy techniques for some types of cancers performed at community-based hospitals result in inferior outcomes. Our goal was to assess the implementation of this technology by studying efficacy and toxicity of SBRT on liver metastases at a non-academic, community-based hospital through retrospective database analysis.Materials/Methods: We performed an IRB approved patient registry study at a non-academic, community-based hospital. Patients had a median age of 65, KPS of at least 70 (median 90) and primary tumor controlled. All patients underwent fiducial marker placement under CT-guidance 1-2 weeks prior to planning scans. GTV was delineated using contrast enhanced CT scans, as well as fusion with PET and/or MRI scans. GTV was expanded by 5 mm to create the PTV. Treatment was delivered by image guided stereotactic robotic radiosurgery with respiratory motion tracking. Lesions were treated with 3 consecutive fractions to a median total dose of 54Gy. Overall survival, progression-free survival and local failure-free survival were estimated using Kaplan-Meier method. To investigate the relationship between tumor volume and local control, we dichotomized our data set at the mean. Log-rank statistic was used to compare local control based on gross tumor volume.Results: Between 2006 and 2016, 42 consecutively treated patients with 81 metastatic liver lesions were treated with SBRT. Median follow up was 25 months. Primary tumor sites were colon (18), lung (7), breast (3), uterine (3), renal (2), pancreas (2), and others (7). Synchronous extrahepatic disease was present in 15% of the treated lesions at the time of SBRT and 46% had prior local treatment for liver metastases. Median number of lesions treated at one time was 1 (range 1-4). Lesions had a median maximum diameter of 2.5 cm (range 0.5 cm - 9.5 cm), and a mean volume of 53 cc (0.5 cc - 363.0 cc). Kaplan-Meier estimated 1 and 2 year overall survival was 72% and 62%. Estimated 1 and 2 year progression free survival was 32% and 23%. Estimated 1 and 2 year local control was 86% and 80%. 2 year local control was worse for lesions >50 cc compared to lesions <=50 cc (62% vs 84%, p =0.04). Toxicity occurred in 26% of treatment courses and included grade 1 (n=12) (fatigue, diarrhea, nausea, skin irritation and pneumonitis) and grade 2 toxicity (n=3) (chest wall pain and vomiting with mildly elevated transaminase levels).Conclusion: These results are comparable to available published data regarding the safety and efficacy of liver metastasis SBRT on clinical trials at academic institutions. Our findings demonstrate the successful implementation of a liver metastasis SBRT program in a community hospital setting.

SSJ24-04 Assessment of Radiographic Changes after Radiotherapy for Hepatocellular Carcinoma

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S104A

Participants
Onyinye D. Balogun, MD, New York, NY (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Hepatocellular carcinoma (HCC) is the most frequent primary liver tumor in adults and it is the fifth most common cancer in the world. Radiotherapy is increasingly being used to treat hepatocellular malignancies. However, there are no standard imaging protocols for evaluation of tumors treated with radiotherapy. Our study reports the radiological changes noted on MRI and/or CT scan in hepatocellular cancer patients after undergoing radiation therapy to a primary tumor.Materials/Methods: CT scans and MRIs of hepatocellular cancer patients who underwent stereotactic or hypofractionated radiotherapy between 2011 and 2016 at a single institution were evaluated prior to and after radiotherapy. Eligible patients had to have at least one imaging study after radiotherapy. Variables including lesion volume, arterial enhancement with or without portal venous washout, and presence of

a pseudocapsule were evaluated.Results: Fifteen patients with radiologic studies after radiotherapy were treated between 2011 and 2016. Primary tumor size ranged from 1.2 to 16 cm. Radiotherapy was delivered in 1-15 fractions (mean 7.2 fractions). Treatment doses ranged from 800 to 5805 cGy (mean 3794 cGy). Per institutional practice, initial follow-up imaging was usually performed at approximately 1 month after treatment. CT and MRI were utilized in 7 and 8 patients, respectively, for initial follow-up evaluation. Over 70% of tumors maintained characteristics of pseudocapsule presence and arterial enhancement with portal venous washout at initial imaging and were classified as stable according to modified RECIST assessment for hepatocellular carcinoma. Of note, three patients exhibited tumor decrease within two weeks of treatment completion. Radiographic assessment is ongoing and additional endpoints will be reported.Conclusion: The findings of this study will add to the existing limited literature regarding characteristic radiation-induced changes in primary liver tumors and surrounding liver parenchyma. Together, these studies can provide a framework for the standardized assessment of tumor response after radiotherapy.

SSJ24-05 Sequencing of Chemotherapy and Radiation Therapy in the Treatment of Extrahepatic Cholangiocarcinoma and Gallbladder Carcinoma

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S104A

Awards
Trainee Research Prize - Medical Student

Participants
Jonathan Van Wickle, Milwaukee, WI (*Presenter*) Nothing to Disclose

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ABSTRACT

Purpose/Objective(s): Primary malignancies of the Gallbladder and Extrahepatic biliary system (EHC-Gal) are rare. There are advantages to pre-operative chemoradiation (chemo-RT) in malignancies such as pancreatic adenocarcinoma. The objective of this study was to explore the benefit, if any, of neoadjuvant chemo-RT in patients with EHC-Gal malignancies who are not candidates for transplant, using the National Cancer Database (NCDB). We hypothesized that the use of neoadjuvant chemo-RT may improve outcomes.Materials/Methods: The NCDB was queried for patients with EHC-Gal between the years of 2006-2012. Patients without metastatic disease at the time of diagnosis, who underwent surgical resection, and received either pre-operative or post-operative chemo-RT, with radiation therapy doses between 40 Gy and 70 Gy, were included. Patients with ampulla of Vater involvement, those treated with stereotactic body radiation therapy (SBRT) or liver transplant were excluded. Baseline covariates were compared between treatment groups. Overall survival (OS) by treatment group was plotted using Kaplan-Meier methods. Univariate and multivariate Cox proportional hazards regression, incorporating inverse probability of treatment weighting (IPTW) to account for selection bias, were used to model time from diagnosis to death. The twang R package was used to calculate propensity scores and the average treatment effect of the treated (ATT) weights; the weighted estimate represents the treatment effect on the treated population. Results: Among the 561 patients meeting inclusion criteria, 34 (6%) received pre-operative chemo-RT. Among the entire cohort of 561 patients with EHC-Gal, the median age was 64 years, 47% were male, and 81% were Caucasian. Overall, 29%, 49% and 22% were clinical stage I, II, and III, respectively. Patients treated with pre-operative chemo-RT were more likely to be younger, have fewer medical comorbidities, have earlier clinical stage disease, and be treated at academic centers. Following surgical resection, patients treated with pre-operative chemo-RT had significantly higher rates of node negativity (65% vs. 34%, p Conclusion: Among a contemporary NCDB cohort of 561 patients with EHC-Gal, few patients received preoperative chemo-RT. Compared to patients treated with post-operative chemo-RT, patients treated with pre-operative chemo-RT had lower rates of positive margins and node positivity. This did not translate into a statistically significant difference in OS. This may be related to a dominant pattern of distant failure and short median survival in EHC-Gal. Further investigation into pre-operative therapy in EHC-Gal is warranted.

SSJ24-06 Does Radical Resection Obviate the Benefit of Adjuvant RT in Gallbladder Cancer?

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S104A

Participants
Joseph Marascio, MD, philadelphia, PA (*Presenter*) Nothing to Disclose

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ABSTRACT

Purpose/Objective(s): Gallbladder cancer (GC) is a rare aggressive malignancy for which optimal adjuvant treatment is not well studied. Studies showing benefit to adjuvant CRT have typically included advanced T stage or node positive patients and have largely been single institution retrospective reviews or analyses of historical databases. Often in these reviews, simple cholecystectomy was the chief technique, but more recently this has been replaced by radical resection. The purpose of this study is to compare the impact of adjuvant RT in simple vs radical resection. Materials/Methods: The Surveillance, Epidemiology and End Results (SEER) database was used to identify patients diagnosed with GC between 2004 and 2013 who underwent simple or radical cholecystectomy. Patients were classified according to AJCC 6th edition and included if stage IIA, IIB or III. Patients with metastatic disease and those surviving fewer than 3 months were excluded. Overall survival (OS) was then calculated for patients who received adjuvant RT or no RT with respect to simple or radical resection. Results: For patients undergoing radical resection, 266 patients who met the above criteria were identified. 121 received adjuvant RT and 145 did not. In the adjuvant RT group the median age was 61 and staging was as follows: IIA 28.9%, IIB 65.3%, and III 5.8%. For those not receiving RT the median age was 67 and staging was as follows: IIA 41.4%, IIB 44.8%, and III 13.8%. In the adjuvant RT group the median survival was 23.4 months, 1 year OS was 87.4% (95 CI 79.6 – 92.3%) and 3 year OS was 35.3% (95 CI 25.7 – 44.9%). In those not receiving RT the median survival was 11.9 months, 1 year OS was 49.5% (95 CI 40.8 – 57.7%), and 3 year OS was 23.8% (95 CI 16.6 - 31.8%).For patients undergoing simple resection, 866 patients who met the above criteria were identified. 289 received adjuvant RT and 577 did not. In the adjuvant RT group the median age was 65 and staging was as follows: IIA 34.6%, IIB 62.3%, and III 2.8%. For those not receiving RT the median age was 72 and staging was as follows: IIA 52.5%, IIB 44%, and III 3.5%. In the adjuvant RT group the median survival was 21.1 months, 1 year OS was 75.8% (95 CI 70.3 – 80.5%) and 3 year OS was 31.3% (95 CI 25.4 – 37.3%) For those not receiving RT the median survival was 12.8 months, 1 year OS was 52.5% (95 CI 48.3 – 56.6%) and 3 year OS was 21.1% (95 CI 17.6 – 24.8%). Conclusion: In the simple resection group a significant OS benefit is seen in those

receiving adjuvant RT at 1 and 3 years. Similarly, this benefit is seen in the radical group at 1 year, however significance is lost at 3 years. These findings reflect a benefit to adjuvant RT shown in prior studies for simple resection, but also support an improved OS in those undergoing radical resection. A weakness in this review is the lack of chemotherapy data as adjuvant RT may be a surrogate for adjuvant chemotherapy. Similarly, patients of greater performance status may be more likely to be selected for adjuvant treatments.

SSJ25

Vascular Interventional (Aortic Intervention and Vasculitis)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E352

IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants

Gordon McLennan, MD, Chagrin Falls, OH (*Moderator*) Research Grant, Siemens AG; Research Consultant, Medtronic plc; Advisory Board, Siemens AG; Advisory Board, Surefire Medical, Inc; Advisory Board, Stealth Medical; Advisory Board, Rene Medical; Data Safety Monitoring Board, B. Braun Melsungen AG
Hyeon Yu, MD, Seoul, Korea, Republic Of (*Moderator*) Nothing to Disclose

Sub-Events

SSJ25-01 Dual Contrast Agent Based Spectral Photon-Counting Computed Tomography for Detection of Endoleaks Following EVAR: A Phantom Study

Tuesday, Nov. 28 3:00PM - 3:10PM Room: E352

Participants
Julia Dangelmaier, MD, Munich, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

After endovascular aortic repair (EVAR) discrimination of leaking contrast media and calcifications of similar attenuation within the aneurysm sac is challenging and often requires multiple CT acquisitions. Dual contrast agent based spectral photon-counting CT (SPCCT) may provide reliable detection of endoleaks with a single CT acquisition.

METHOD AND MATERIALS

To experimentally evaluate the potential of SPCCT, an aortic phantom was in-house designed and produced. A centrally located stent lined compartment was filled with water as well as with iodine and gadolinium mimicking contrast-enhanced blood within the aortic lumen. To represent the endoleak, the adjacent compartments contained either one of the contrast agents or calcium chlorine to mimic calcifications. After data acquisition with a small field-of-view spectral photon-counting computed tomography prototype scanner with multi-energy bins, material decomposition was performed to generate iodine, gadolinium and calcium maps.

RESULTS

In a conventional CT slice, Hounsfield Units of the different compartments were similar ranging from about 145 HU up to 170 HU. Material specific maps clearly differentiate the distributions within the compartments filled with iodine, gadolinium or calcium.

CONCLUSION

A single dual contrast agent based spectral photon-counting CT scan may replace conventional CT scans in native, arterial and delayed phase to detect endoleaks of different flow rates without interference from existing calcifications after endovascular aortic repair. It is a unique feature of the dual contrast spectral photon-counting CT scan to capture different endoleak dynamics in a single scan. Additionally, a significant reduction of radiation exposure is enabled.

CLINICAL RELEVANCE/APPLICATION

Dual contrast SPCCT with material decomposition offers extended endoleak diagnostics by a single acquisition.

SSJ25-02 Long-Term Result of Thoracic Endovascular Aortic Repair for Retrograde Type A Aortic Dissection

Tuesday, Nov. 28 3:10PM - 3:20PM Room: E352

Participants
Takatoshi Higashigawa, MD, Tsu, Japan (*Presenter*) Nothing to Disclose
Noriyuki Kato, MD, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose
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Ken Nakajima, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose
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Shuji Chino, MD, Matsusaka, Japan (*Abstract Co-Author*) Nothing to Disclose
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Tomoaki Sato, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose
Hajime Sakuma, MD, Tsu, Japan (*Abstract Co-Author*) Research Grant, Fuji Pharma Co, Ltd; Research Grant, DAIICHI SANKYO Group; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Siemens AG; Research Grant, NIHON MEDIPHISICS; Speakers Bureau, Bayer AG

PURPOSE

To report the long-term result of thoracic endovascular aortic repair (TEVAR) for retrograde type A aortic dissection with the entry tear in the descending aorta.

METHOD AND MATERIALS

Medical records of thirty-one patients who underwent TEVAR for the treatment of retrograde type A aortic dissection at four institutions were retrospectively reviewed.

RESULTS

There were 30 men and one women. The mean age was 64 ± 11 years old. The entry tear was located in the descending thoracic aorta in all patients. The false lumen of the ascending thoracic aorta was patent in 12 patients (40%), while it was thrombosed in the remaining 19 patients (60%). The false lumen of the descending thoracic aorta was patent in 17(55%) patients and most of it was thrombosed in the other 14 patients (45%). TEVAR was performed in acute phase in 24 patients (77%) and in subacute phase in 7 patients (23%). Only one patient died of aortic rupture within 30 days (3%). Early aorta-related adverse events were observed in 7 patients (23%) (type Ia endoleak: 3, type II endoleak: 1, intimal injury: 1, saccular aneurysm formation in the descending aorta: 1, patent false lumen in the ascending aorta: 1) and additional interventions including surgical conversion and additional placement of stent grafts were required in four of them. The mean follow-up period was 97 ± 68 months. Although no aorta-related death was observed, five patients died during follow-up (suicide: 1, trauma: 1, pancreatic cancer: 1, pneumonia: 1, hepatocellular carcinoma: 1). Overall survival rate at 1, 5, and 10 years was 97%, 93%, and 80%, respectively. Late aorta-related adverse events were observed in 7 (27%) patients (intimal injury: 3, newly-developed type A aortic dissection: 3, dissecting abdominal aortic aneurysm: 2, left arm ischemia: 1). Aorta-related event free rate at 1, 5, and 10 years was 61%, 56%, and 56%, respectively.

CONCLUSION

TEVAR for retrograde type A aortic dissection seems promising in terms of survival rate. However, taking into consideration that aorta-related adverse event develops at a non-negligible rate, we should be careful in selecting patients.

CLINICAL RELEVANCE/APPLICATION

TEVAR is an effective treatment option for retrograde type A aortic dissection with entry tear in the descending thoracic aorta.

SSJ25-03 To Assess the Role of FDG PET/CT in Evaluating the Large Vessel Vasculitis and Disease Activity

Tuesday, Nov. 28 3:20PM - 3:30PM Room: E352

Participants
Sikandar M. Shaikh, DMRD, Hyderabad, India (*Presenter*) Nothing to Disclose

PURPOSE

To assess the value of PET-CT in the evaluating the disease activity in large vessel vasculitis .

METHOD AND MATERIALS

29 PET/CT scans were performed in 28 pts with large vessel vasculitis (giant cell arteritis, Takayasu arteritis or idiopatic aortitis). PET-CT was done after injecting FDG contrast with and without iv contrast.Vascular uptake was graded using a 4-point scale (0=no uptake, 1=less than liver, 2=similar to liver, 3=higher than liver). Grade 0-1 was negative, 2 was moderately positive and 3 was markedly positive. PET/CT was correlated with clinical indices including ITAS (Indian Takayasu Activity Score) and Kerr/National Institute of Health (Kerr/NIH), serum acute-phase reactants (ESR, C-reactive protein [CRP]) levels as well as interleukin-6 (IL-6) and the soluble IL-6 receptor (sIL-6R).

RESULTS

43% of 29 PET-CT were negative, 31% were moderately positive, and 26% were markedly positive. Further correlation was done with ESR and CRP levels. Significantly higher ESR values were observed in patients with markedly positive PET/CT (49.4 + 36.5 mm/1st h) compared with moderately positive (27+ 21 mm/1st h, p = 0.0001) and inactive scans (22.7 + 15.9 mm/1st h, p=0.0001). CRP levels were 0.8+1.0 mg/dL in pts with inactive scans, 1.3+ 2.2 mg/dL in pts with moderately positive (p=0.001) and 3.0 + 3.6 in patients with markedly positive scans (p = 0.0001). Higher levels of IL-6 resulted in patients with markedly positive scans (10.0 + 8.9 pg/ml) compared to those with inactive scans (8.1+18.5 pg/ml, p=0.013). We found no association between sIL-6R levels and vascular FDG uptake. There was a significant association between vascular FDG uptake and both ITAS and Kerr/NIH scores.

CONCLUSION

Our evaluation showed significant amount of FDG sensitivity in relation to the metabolic uptake along the vessel walls.In the clinical scenario it was helpful in evaluating borderline cases of Vasculitis where no modality shows significant sensitivity in diagnosing

CLINICAL RELEVANCE/APPLICATION

FDG PET-CT is now proven and established modality for evaluating the large cell vasculitis.

SSJ25-04 Predictors for Blood Pressure Response after Unilateral and Bilateral Stents Placement of Atherosclerotic Renal Artery Stenosis

Tuesday, Nov. 28 3:30PM - 3:40PM Room: E352

Participants
Xueying Lin, MD, Fuzhou, China (*Presenter*) Nothing to Disclose
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PURPOSE

To explore the difference of BP response between the unilateral and bilateral stenting, and the potential predictors for BP response.

METHOD AND MATERIALS

Retrospectively collected ARAS patients who underwent PTRAS and pre-stenting renal artery (RA) ultrasonography (US) exams in 5 years at a single institution. Patients with accessory RA and contralateral RA occultation were excluded. Baseline characteristics, including age, gender, pre-procedure BP, eGFR, and differences of bilateral US parameters (kidney length, PSV, RAR, and RI) were collected. Pre-stenting BPs and anti-hypertension medication were recorded, and were followed up at 1, 3, 6, 12 and 18 months. The BP response was classified into benefit (cure/improvement) or failure based on the guideline (2003), and the occurrence of BP benefit (study endpoint) and the time from stenting to BP benefit (month) were recorded.

RESULTS

Totally 101 ARAS patients underwent stenting were identified. After removing 14 cases with accessory RA, 9 cases with contralateral RA occultation, 12 cases without qualified data, leaving a cohort of 66 patients, including 43 (age 74.72±10.51 years, male/female 18:25) with unilateral RA stenting, and 23 (Age 69.96±13.34 years, male/female 13:10) with bilateral RA stenting. 74.4% (32/43) of unilateral stenting and 82.6% (19/23) of bilateral stenting were found BP benefit within 6 months after stenting. As in Figure 1, Log rank analysis showed no difference of BP benefit between the two groups (P=0.199). Univariate Cox analysis revealed only the bilateral PSV difference was the predictor for the BP benefit.

CONCLUSION

This study demonstrated, patients underwent unilateral and bilateral stents had similar BP response. The cure/improvement of hypertension most commonly occurred within 6 months after stenting, and higher difference of pre-stenting bilateral PSVs may be its predictor.

CLINICAL RELEVANCE/APPLICATION

The blood pressure (BP) response to unilateral and bilateral percutaneous transluminal renal angioplasty with stent placement (PTRAS) of atherosclerotic renal artery stenosis (ARAS) has not been compared.

SSJ25-05 Experimental Rabbit Study to Evaluate the Effect of Botulinum Toxin Type A Injection Into the Perirenal Arterial Space to Treat Hypertension

Tuesday, Nov. 28 3:40PM - 3:50PM Room: E352

Participants
Akinaga Sonoda, MD, PhD, Otsu, Japan (*Presenter*) Nothing to Disclose
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Shinichi Ota, MD,PhD, Otsu, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To develop effective renal sympathetic denervation for antihypertensive therapy, we percutaneously injected the perirenal arterial space of rabbits with botulinum toxin A (BTA).

METHOD AND MATERIALS

Our study was approved by the ethical animal laboratory committee and followed the Animal Care Guidelines of our institution. Six Japanese white rabbits (JW) and 6 Watanabe heritable hyperlipidemic rabbits (WHHL), an arterial sclerosis rabbit model, were randomly divided into two groups. Group 1 (JW, WHHL; n=3 each) was injected with 0.32 ml saline and group 2 (JW, WHHL; n=3 each) with 0.32 ml (8 units) of BTA. All injections were percutaneous and into the perivascular space surrounding the bilateral renal arteries using an ultrasound device. Before and one week- and 1-, 2-, 3-, and 4 months thereafter, their systolic blood pressure (SBP) and heart rate (HR) were measured in the right femoral artery. Significant differences ($p<0.05$) were determined with

Student's t-test.

RESULTS

No rabbits lost appetite or died due to the procedures. At one month post-injection, the SBP of botox-treated animals fell by 23.66+14.77 mmHg; in JW rabbits the difference from the baseline was not- while in WHHL rabbits it was significant ($p<0.08$ vs $p<0.05$). At 2 to 4 months post-injection, the SBP decrease between the two groups was not significantly different. There was no significant difference in the HR of both groups during 4 month.

CONCLUSION

While the percutaneous injection of BTA into the perivascular space around the bilateral renal arteries of rabbits may elicit an SBP decrease, its effectiveness duration, dose, and injection site require further study. Additional in vivo studies are needed to determine the antihypertensive effect of BTA percutaneously injected around the perirenal arterial space.

CLINICAL RELEVANCE/APPLICATION

This procedure may result in better antihypertensive therapy and facilitate new interventional radiology procedures.

SSJ25-06 Imaging Abdominal Large Vessel Vasculitis: The Diagnostic Value of T1 3D mVISTA Black Blood MRI

Tuesday, Nov. 28 3:50PM - 4:00PM Room: E352

Awards
Student Travel Stipend Award

Participants
Stefan Maurus, MD, Munich, Germany (*Presenter*) Nothing to Disclose
Nora Sommer, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Tobias Saam, MD, Munich, Germany (*Abstract Co-Author*) Research Grant, Diamed Medizintechnik GmbH Research Grant, Pfizer Inc
Hendrik Kooijmann, PhD, Hamburg, Germany (*Abstract Co-Author*) Employee, Koninklijke Philips NV
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Claudia Dechant, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Hendrik Schulze-Koops, MD,PhD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Karla Maria Treitl, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the diagnostic performance of a T1-3D black blood TSE (turbo-spin echo) sequence in patients with abdominal large vessel vasculitis (aLVV).

METHOD AND MATERIALS

20 patients diagnosed with aLVV according to the reference standard and 17 controls were enrolled in this single center study and subjected to 3.0 T imaging. The protocol included a pre and post gadoteric acid, free-breathing, peripheral pulse-unit triggered T1 3D modified Volumetric Isotropic TSE Acquisition (T1-mVISTA) sequence and a segmented T1 3D turbo-field-echo sequence (T1-eTHRIVE). Two independent blinded readers evaluated the aorta and its main branches on a per-segment basis for concentric wall thickening (CWT) and concentric contrast enhancement (CCE) as signs of inflammation as well as image quality (IQ), flow artefact intensity (FAI) and diagnostic confidence level (DCL), using 4-point Likert scales. Scoring results were compared between the T1-mVISTA and the T1-eTHRIVE sequence using accuracy parameters and inter-reader agreement. Additionally the mean aortic wall thickness (MAWT) was determined on post contrast T1-mVISTA images and compared between aLVV-patients and controls.

RESULTS

IQ was diagnostic in all 37 examinations. Scan time of the mVISTA sequence was 4:10 min at an average heart rate of 80 bpm. In 91.5% of 282 evaluated vessel segments IQ was rated good to excellent with absent or only minor flow artefacts in 85.4%. Inter-observer reproducibility and DCL for CCE and CWT was excellent (0.92/0.93; $P<0.001$; 3.54±0.52/3.50±0.63). Comparing the T1-mVISTA to the T1-eTHRIVE Sequence showed high correlation for the diagnostic signs of aLVV with a kappa of 0.740 for CCE and 0.702 for CWT ($P<0.001$). Using T1-eTHRIVE as reference standard resulted in in a sensitivity of 87.8%, a specificity of 83.3% and an accuracy of 85.2% of T1-mVISTA with a positive and negative predictive value of 79.6% and 90.2%. There was a significant difference in MAWT of the suprarenal and infernal aorta between aLVV-patients and controls (3.60±0.65/3.04±0.85 mm vs. 2.32±0.44/2.18±0.44 mm; $P<0.001$).

CONCLUSION

Imaging of aLVV with navigated T1-mVISTA black blood MRI is feasible, allows the detection of inflamed vessel segments and provides high IQ as well as high resolution, combined with a relatively short scan time.

CLINICAL RELEVANCE/APPLICATION

T1 3D mVISTA black blood MRI could become a valuable imaging tool for the diagnosis and follow-up of patients with aLVV.

SSJ26

Vascular Interventional (Gastrointestinal/Genitourinary)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S402AB

GI GU IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
James T. Bui, MD, Chicago, IL (*Moderator*) Nothing to Disclose
Nikunj R. Chauhan, MD, Cleveland, OH (*Moderator*) Nothing to Disclose

Sub-Events

SSJ26-01 Image Guided Cholecystostomy Tube Placement: Short and Long Term Outcomes of Transhepatic versus Transperitoneal Placement

Tuesday, Nov. 28 3:00PM - 3:10PM Room: S402AB

Participants
Michael D. Beland, MD, Providence, RI (*Presenter*) Research Grant, Toshiba Medical Systems Corporation
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PURPOSE

Image guided percutaneous cholecystostomy (PC) may be performed transhepatic (TH) or transperitoneal (TP). The TH approach is traditionally preferred and recommended when possible. We compared the short and long term outcomes of PC related to route of catheter placement.

METHOD AND MATERIALS

IRB approved, HIPAA compliant retrospective review of imaged guided PC was performed from 2004-2016. Search of the hospital RIS was performed using keywords including "percutaneous cholecystostomy" "gallbladder drain" and "cholecystostomy tube" and relevant procedural terminology (CPT) codes. All search results were manually reviewed to identify the cohort of 373 patients who underwent initial episode of PC placement. Radiology reports and images were reviewed to determine method and route of PC. Chart review was performed to determine clinical outcomes. Imaging studies following PC placement were reviewed when necessary to determine catheter course or complications. Differences were examined using a generalized linear model assuming a binary distribution and logit function with SAS/GLIMMIX.

RESULTS

Of the 373 patients, PC placement was performed using US in 229, US access with fluoroscopy in 129, CT in 14, fluoroscopy in 1. Trocar technique was used in 183 and seldinger in 190. 218 PC were placed TH and 153 were TP. The most common PC catheter sizes were 8 French (83), 8.5 French (151), 10 French (124), and 12 Fr (13). There was no significant difference observed between the TH and TP approach for bleeding (1.54% vs 0.91%, p=0.25), pain (2.16% vs 1.68%, p=0.85) or premature catheter dislodgement (3.15% vs. 2.61%, p=0.90). Odds of drain exchange were not different between TH (32%) and TP (24%), p=0.23. Odds of subsequent drain replacement were not different between TH (8%) and TP (10%), p=0.73. Median length of stay was 7 days for both TH and TP (p=0.96). Survival was not different (TH 1.8 years, TP 2.8 years; p=0.12).

CONCLUSION

Transperitoneal PC was not associated with increased incidence of bleeding, pain or premature catheter dislodgement. There was no significant difference between TP and TH placement for needing subsequent drain exchange, median hospital stay or survival.

CLINICAL RELEVANCE/APPLICATION

Placement of percutaneous cholecystostomy can be safely performed transhepatically or transperitoneally with similar short and long term outcomes. Choice of route should be based on the patient's anatomy.

SSJ26-02 Predictors of Clinical Outcomes of Self-Expandable Metal Stent Use to Palliate Malignant Esophagorespiratory Fistulas in 105 Patients

Tuesday, Nov. 28 3:10PM - 3:20PM Room: S402AB

Participants
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Jung-Hoon Park, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

to identify the predictors associated with clinical outcomes (initial and late clinical failure) and patient survival after self-expandable metal stent placement for malignant esophagorespiratory fistulas in 105 consecutive patients.

METHOD AND MATERIALS

All included patients were reviewed using logistic and Cox regression analysis.

RESULTS

Technical success was achieved in all patients. The initial clinical success rate was 78.1% (82/105; 95% confidence interval [CI], 69.3%-84.9%), and clinical success was maintained until the end of the follow-up in 47.6% (50/105; 95% CI, 38.3%-57.1%) of patients. The major complication rate was 26.7% (28/105; 95% CI, 19.1%-35.8%). A stricture length of 5-10 cm (odds ratio [OR] 0.335; 95% CI, 0.122-0.889) and stenting only in the airway (OR, 12.445; 95% CI, 1.086-284.863) were independent predictors of initial clinical failure, and stricture at the upper esophagus (OR, 3.722; 95% CI, 1.276-11.544) was an independent predictor of late clinical failure. The independent predictors of survival were fistulas opening to the pleura (hazard ratio [HR], 3.313; 95% CI, 1.142-9.605) and initial clinical failure (HR, 2.510; 95% CI, 1.490-4.228).

CONCLUSION

Self-expandable metal stent placement is safe and effective for treating malignant esophagorespiratory fistulas.

CLINICAL RELEVANCE/APPLICATION

A stricture length of 5-10 cm, stenting only in the airway, and the stricture at the upper esophagus are independent predictors of treatment failure, whereas a fistulas opening to the pleura and initial clinical failures are independent predictors of shorter survival.

SSJ26-04 Recurrent Benign Urethral Strictures Treated with Covered Retrievable Self-Expandable Metallic Stents: Long-term Outcomes over an 18-year Period

Tuesday, Nov. 28 3:30PM - 3:40PM Room: S402AB

Participants
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PURPOSE

To assess the long-term outcomes of covered retrievable self-expandable metallic stent (REMS) placement for recurrent benign urethral stricture and to compare the outcomes of three types of covered REMS.

METHOD AND MATERIALS

November 1998 to December 2016, 114 REMSs were placed in 54 men. These included 26 polyurethane (PU)-covered REMSs in 13 patients (Group A), 47 internally polytetrafluoroethylene (PTFE)-covered REMSs in 21 patients (Group B), and 41 externally PTFE-covered REMSs in 20 patients (Group C). The outcomes were analyzed and compared between the groups.

RESULTS

Overall clinical success was achieved in 14 (24%) of the 54 patients at the 5-year follow-up (Group A, 12%; Group B, 19%; Group C, 40%). The overall complication rate was 60.5%, and complication rates were significantly different between the groups ($p = 0.004$). The median maintained patency period was 108 months. In multivariate analysis, stent indwelling time was the only significant factor associated with maintained patency.

CONCLUSION

The long-term outcome of covered REMSs has not achieved the desired success rate for the standard treatment of recurrent bulbar urethral stricture. However, externally PTFE-covered REMS showed a better long-term outcome than the other studied types.

CLINICAL RELEVANCE/APPLICATION

Externally PTFE-covered REMS has low complication rate and long stent patency. Externally PTFE-covered REMS showed no tissue ingrowth and low stent migration rate. Longer stent indwelling time contributes to a high clinical success rate. Long-term outcome of covered REMSs has not achieved the desired success rate.

SSJ26-05 EW-7197-Eluting Nanofiber-covered Self-expandable Metallic Stent to Prevent Granulation Tissue

Formation in a Canine Urethral Model

Tuesday, Nov. 28 3:40PM - 3:50PM Room: S402AB

Participants
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PURPOSE

To evaluate an EW-7197-eluting nanofiber-covered stent (NFCS) for suppressing granulation tissue formation after stent placement in a canine urethral model.

METHOD AND MATERIALS

All experiments were approved by the committee of animal research. A total of 12 NFCSs were placed in the proximal and distal urethras of six dogs. Dogs were divided into two groups with 3 dogs each. The control stent (CS) group received NFCSs and the drug stent (DS) group received EW-7197 (1000 μg)-eluting NFCSs. All dogs were sacrificed 8 weeks after stent placement Histologic findings of the stented urethra were compared using the Mann-Whitney U test.

RESULTS

Stent placement was technically successful in all dogs without procedure-related complications. On urethrographic analysis, the mean luminal diameter was significantly larger in the DS group than in the CS group at 4 and 8 weeks after stent placement (all $p < 0.001$). On histological examination, mean thicknesses of the papillary projection, thickness of submucosal fibrosis, number of epithelial layers, and degree of collagen deposition were significantly lower in the DS group than in the CS group (all $p < 0.001$), whereas the mean degree of inflammatory cell infiltration was not significantly different ($p > 0.05$). The in vitro release study demonstrated that approximately 80% of the drug was eluted from the stents within 1 day after which the elution rate slowed and reached a plateau after 10 days.

CONCLUSION

The EW-7197-eluting NFCS is effective and safe for suppressing granulation tissue formation after stent placement in a canine urethral model.

CLINICAL RELEVANCE/APPLICATION

The direct and local therapy with EW-7197 via a covered stent is effective and safe for suppressing granulation tissue formation after stent placement in a canine urethral model.

SSJ26-06 Outcomes of Percutaneous Cholecystostomy Tube Placement in 419 Patients: A Single Institute Experience

Tuesday, Nov. 28 3:50PM - 4:00PM Room: S402AB

Participants
Daniel J. Young, MD, Saint Louis, MO (*Presenter*) Nothing to Disclose
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PURPOSE

To determine proportion of patients who undergo definitive treatment of acute cholecystitis (AC), either surgical cholecystectomy or percutaneous cholecystolithotomy, following percutaneous cholecystostomy (PC).

METHOD AND MATERIALS

Retrospective study was performed with institutional review board approval, and the requirement to obtain informed consent was waived. 419 patients that underwent PC at our institution between July 2010 and September 2016 were included. Patients who underwent PC for indication other than AC were excluded from analysis. Primary outcome was definitive treatment of AC following PC, including cholecystectomy or percutaneous cholecystolithotomy. Secondary outcomes include removal of drainage catheter without further management or death with catheter in place.

RESULTS

During the study period, 377 of 419 patients underwent PC for treatment of AC (mean age, 64.5 years; range 18-100 years). Diagnosis of AC was made via sonography (51%), computed tomography (29%), or hepatobiliary scan (20%). Technical success rate of PC at our institution was 100% with few complications (major 2.4%, minor 1.6%). Following PC, 118 patients (31%) underwent definitive treatment with cholecystectomy. Sixty-one patients (16%) underwent definitive treatment with percutaneous cholecystolithotomy with removal of catheters. Seventy-four patients (20%) had their catheters removed upon resolution of cholecystitis without undergoing surgery or stone removal. Definitive treatment differed between calculous and acalculous cholecystitis groups with the former undergoing further intervention more frequently, while the acalculous group were more likely to have their drain removed without further treatment ($p<0.001$). Fifty patients (13%) died with catheters in place due to other comorbidities. Five patients (1%) still had their catheters in place at the end of the study period.

CONCLUSION

About half of patients with AC that had PC underwent subsequent treatment with surgery or percutaneous cholecystolithotomy. Percutaneous cholecystostomy remains a viable option for treatment of AC with low complication rate, and can be used as bridge to definitive therapy or as sole treatment for alleviation of symptoms associated with AC.

CLINICAL RELEVANCE/APPLICATION

PC can be used for early management of AC when plan for definitive treatment is unclear. The procedure is safe, has low complication rate, and prevents progression to sepsis in patients with AC.

RSNA 2017 Explore. Invent. Transform.
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SSK01

Breast Imaging (Intervention Path Correlation)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: E450A

BR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSK01-01 Reflector-guided Breast Tumor Localization versus Wire Localization for Lumpectomies: A Comparison of Surgical Outcomes

Awards
Student Travel Stipend Award

Participants
Sejal N. Patel, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

To compare surgical outcomes of SAVI SCOUT reflector localization (SSL) versus wire localization (WL).

METHOD AND MATERIALS

An IRB approved retrospective study was conducted. Inclusion criteria were single SSL or single WL with subsequent surgery performed by a single-surgeon (SF) to eliminate inter-operator variability. Exclusion criteria were bracketed lesions, multicentric disease and patients with neo-adjuvant chemotherapy. Tumors measuring greater than 2 cm were also excluded due to variability in neoadjuvant utilization and bracketing. Among 97 patients that underwent SSL and excised by SF from 7/2015 to 1/2017, 42 patients met the criteria. For the WL group, 42 consecutive patients were selected matched for age, size of the tumor and single WL performed from 1/2015 to 6/2015. Final surgical pathology was recorded including tumor size, histologic type, ER/PR/HER2/Ki67 status, margin status and re-excision rates. Positive and close margins were defined as tumor on ink and tumor <=1 mm from ink, respectively. Statistical analysis was performed (SPSS, v24).

RESULTS

100% (42/42) of SSL was performed prior to the day of the surgery (range 1-10 days, mean 2.8 days and median 2 days) and all were successfully excised. All patients (42/42) with WL underwent same day wire placement with successful excision. There was no significant difference in clinical-pathologic features between the SSL and WL groups (p>0.05). The mean distance [0.4 cm (range 0-1.9 cm)] between the target and SSL reflector on post localization mammogram was not statistically different than the mean distance [0.3 cm (range 0-1.3 cm)] between the target and the re-enforcement segment of the wire (p=0.45). No significant differences were present in surgical outcomes (p>0.05) including rates of re-excision (SSL, 7.1% vs. WL, 9.5%), margin positivity (SSL, 9.5% vs. WL, 7.1%), close margins (SSL 7.1% vs. WL, 11.9%) and specimen volume (SSL, 15.2 cm3 vs. WL, 16.3 cm3).

CONCLUSION

SSL is an acceptable alternative to WL with no significant differences in surgical outcomes with previously described advantages of SSL in scheduling efficiency and less patient discomfort.

CLINICAL RELEVANCE/APPLICATION

Reflector guided breast tumor localization can be done prior to the day of surgery and overcomes many of the limitations of wire localization with comparable surgical outcomes.

SSK01-02 Ultrasound Guided High Intensity Focused Ultrasound Ablation of Breast Fibroadenoma: A Pilot Study

Wednesday, Nov. 29 10:40AM - 10:50AM Room: E450A

Participants
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PURPOSE

Fibroadenoma is a common benign breast mass that can cause pain or an undesirable palpable lump. Current management includes observation, core needle biopsy, and/or surgical excision. This study evaluates the safety, feasibility, and efficacy of Ultrasound guided High Intensity Focused Ultrasound (USgHIFU) ablation for treatment of fibroadenomas. USgHIFU provides noninvasive thermal ablation of the fibroadenoma with real-time US guidance during treatment.

METHOD AND MATERIALS

Twenty women with a palpable breast fibroadenoma were enrolled in a single arm IRB and FDA approved clinical trial (IDE #G130252). Histologic confirmation of fibroadenoma on core needle biopsy was required. Patients underwent treatment utilizing the Echopulse device (Theraclion, France). All tumors had a minimum diameter >= 1 cm with volume between 0.3 cc and 10 cc. Volume calculation formula = length (mm) x width (mm) x height (mm) x π / (6 x 1000) in cc. During treatment, multiple sonications were delivered within the mass to achieve coagulative necrosis. Optimal energy delivered per sonication was established by determining the minimal setting found to produce a hyperechoic mark observed on real-time B-mode image. Energy settings were also influenced by patient tolerance. Change in tumor size, toxicity, cosmesis, and patient experience were obtained immediately after treatment and at 3, 6, and 12 months.

RESULTS

Twenty patients successfully completed therapy. Mean patient age was 35.2. Mean power/sonication = 38.3 watts. Mean number of sonications = 34.3. Pre-treatment mean tumor volume was 1.8cc (SD 1.23, Range 0.57 - 5.7). Mean reduction in volume of the fibroadenoma at 12 months was -1.12 cc (65%), SD -0.61 cc (22%), Range -2.22 to -0.31 cc (98 to 25%), p-value < 0.0001. All adverse events (AE) were grade 1 or 2. Mild pain was the most common AE. No skin burns, damage to adjacent structures, or other major toxicities were observed. On clinical exam, mass was no longer palpable in 80% of patients at 12 months. Patient satisfaction was 4.4 on a scale of 1-5 (5 = most satisfied).

CONCLUSION

USgHIFU ablation is a safe, feasible and efficacious treatment option for breast fibroadenoma. Our results are limited by the small size of our study.

CLINICAL RELEVANCE/APPLICATION

Based on the results of this pilot study, there is evidence to support a larger multi-center clinical trial.

SSK01-03 Incidence of Anaplastic Large Cell Lymphoma in Women with Silicone Breast Implants at MR Imaging

Wednesday, Nov. 29 10:50AM - 11:00AM Room: E450A

Participants
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Elizabeth A. Morris, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the incidence of benign and malignant peri-implant fluid collections and/or masses at magnetic resonance (MR) imaging among women with a history of silicone implant reconstruction.

METHOD AND MATERIALS

The institutional review board approved this HIPAA-compliant retrospective study and waived informed consent. Women were identified who (a) underwent silicone implant oncoplastic and/or cosmetic surgery and (b) underwent postoperative implant-protocol MR imaging to evaluate for rupture between 2000 and 2014. Peri-implant fluid and/or masses were measured volumetrically. A benign peri-implant fluid collection was pathologically proven or defined as showing 1 year of imaging stability and/or no clinical evidence of disease. A malignant peri-implant fluid collection was pathologically proven. Incidence of peri-implant fluid collections and/or masses and positive predictive value (PPV) were calculated on a per-patient level by using proportions and exact 95% confidence intervals (CIs).

RESULTS

In total, 1070 women with silicone implants were included (median age, 56 years; range, 26-95 years). The median time between reconstructive surgery and first MR imaging examination was 48.96 months (range, 24-53months). Of the 1070 women, 263 had more then one imaging study. Of the 1070 women, 18 (1.7%) had a peri-implant fluid and/or mass; 16 (88.9%) had adequate follow-up; only 1 of the 16 peri-implant fluid collections was malignant implant associate anaplastic large cell lymphoma, with a PPV of 6.25% (95% CI: 0.003-0.0005). The median peri-implant fluid collection was 89 cc (range, 18-450 cc).

CONCLUSION

Peri-implant fluid collections and/or masses identified at silicon implant-protocol breast MR imaging are rarely seen 24 months after reconstructive surgery. Image guided fine-needle aspiration with flow cytometry may be warranted to evaluate for implant-associated lymphoma.

CLINICAL RELEVANCE/APPLICATION

Peri-implant fluid collections and/or masses on implant-protocol breast MRI are rarely seen 24 months after surgery and the diagnostic radiologist should consider recommending ultrasound guided fine needle aspiration.

SSK01-04 Feasibility and Accuracy of Digital Breast Tomosynthesis-Guided Vacuum Assisted Breast Biopsy (DBT-VAB) for Non-Calcified Targets

Wednesday, Nov. 29 11:00AM - 11:10AM Room: E450A

Participants
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PURPOSE

To (1) determine feasibility and accuracy of DBT-VAB for non-calcified breast lesions without a sonographic correlate and (2) assess concordance of imaging and pathology findings.

METHOD AND MATERIALS

A HIPAA-compliant IRB waived retrospective review of our mammographic database between 12/11/15-8/31/16, identified 72 women with 73 non-calcified lesions on DBT who underwent attempted DBT-VAB with imaging available for review. Mammography and biopsy imaging were reviewed in consensus by three breast radiologists; imaging features and biopsy parameters were collected. Medical records were reviewed for imaging follow-up, patient characteristics, and histopathology.

RESULTS

The target lesion was sampled by DBT-VAB in 72 of 73 lesions. One biopsy was canceled because the target could not be identified at biopsy. Mean time to complete DBT-VAB was 17.3 minutes +/- 5. No major complications were reported. Findings included: 3 focal asymmetries (FA) (4%), 7 asymmetries (A) (10%), 21 masses (M) (29%) and 41 architectural distortions (AD) (57%). DBT-VAB histopathology showed invasive malignancy in 15 (21%) of 72 lesions: 1/3 FA (33%), 7/41 AD (17%), 7/21 M (33%). ADH was found in 2 (3%) of 72 lesions (both masses). 7/7 A, 2/3 FA, and 11/21 M showed benign core pathology concordant with imaging. 1/21 M had benign discordant core pathology and was malignant on excision. 34/41 (83%) AD were benign on core pathology, of which 14 (41%) were complex sclerosing lesions (CSL); 6 were excised with no upgrades. Ten of 34 (29%) AD were benign and considered concordant with imaging. The remaining 10 of 34 (29%) were benign discordant pathology at core biopsy and surgically excised; 4/10 (40%) showed CSL on final pathology. Therefore, a total of 11/72 (15%) cases were considered discordant on VAB with 1/11 (9%) malignancies on final pathology.

CONCLUSION

DBT-VAB is a quick and feasible biopsy method for targeting non-calcified mammographic lesions without a sonographic correlate. The 21% malignancy rate reaffirms biopsy is necessary for suspicious mammographic lesions occult on ultrasound. Meticulous radiology-pathology correlation is required in interpretation of DBT-VAB results, with surgical excision of discordant cases.

CLINICAL RELEVANCE/APPLICATION

DBT-VAB is a feasible biopsy method for non-calcified lesions, however, careful radiology-pathology correlation is necessary, with a low threshold to surgically excise any potentially discordant cases.

SSK01-05 Optical Coherence Tomography (OCT): A Novel Imaging Method for Ex-Vivo Breast Specimens-A Reader Feasibility Study

Wednesday, Nov. 29 11:10AM - 11:20AM Room: E450A

Participants
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PURPOSE

To assess subspecialty reader sensitivity, specificity and overall accuracy to distinguish non-suspicious versus suspicious areas of

ex-vivo breast tissue using OCT images (a near-infrared based imaging technique) with histology correlation.

METHOD AND MATERIALS

This IRB exempt, HIPAA compliant study was performed on 63 surgically excised breast specimens from 35 female patients. OCT images of the specimens were performed providing micrometer resolution with tissue visualization 1-2 mm subsurface. 40 volumetric image data sets were created from the specimens for reader interpretation (16 malignant cases (8 invasive ductal carcinoma, 4 DCIS, 4 mixed IDC/DCIS) and 24 benign). 3 breast imaging fellowship trained radiologists, 2 pathologists, 2 breast surgeons and 1 non-clinical reader were first trained to interpret OCT images and then read 40 OCT data sets blinded to clinical data and corresponding histology slides. Readers were asked to distinguish non-suspicious from suspicious findings.

RESULTS

Sensitivity, specificity, PPV, NPV, and the AUC for each reader was calculated as well as averages by subspecialty. Histology was the reference standard. The overall average reader sensitivity, specificity and accuracy for all 8 readers was 80%, 87% and 0.87, respectively, Radiologists demonstrated the highest average among the disciplines, 85%, 93% and 0.94, followed by Pathologists, 79%, 90%, and 0.84, and Surgeons, 76%, 84%, and 0.82 respectively.

CONCLUSION

Multidisciplinary readers are able to distinguish suspicious from non-suspicious OCT imaging findings in ex-vivo breast tissue as confirmed by histology. These results support the potential of OCT as a real time intra-operative tool for imaging ex-vivo breast tissue. Future studies are needed to evaluate the technology in an intraoperative setting.

CLINICAL RELEVANCE/APPLICATION

Real time OCT images of ex-vivo breast tissue could be viewed intraoperatively by the surgeon to assess for suspicious tissue at the edge/margin of a specimen. Images could be exported for radiologist consultation.

SSK01-06 Use of Artificial Intelligence to Reduce Breast Biopsies

Wednesday, Nov. 29 11:20AM - 11:30AM Room: E450A

Participants
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Rebecca Rakow-Penner, MD, PhD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose
Hoanh X. Vu, PhD, San Diego, CA (*Abstract Co-Author*) Employee, CureMetrix, Inc
William Daughton, PhD, La Jolla, CA (*Abstract Co-Author*) Employee, CureMetrix, Inc
Eric Weise, San Diego, CA (*Abstract Co-Author*) Researcher, CureMetrix, Inc
William G. Bradley JR, MD, PhD, La Jolla, CA (*Abstract Co-Author*) Officer, CureMetrix, nc

PURPOSE

Almost 2% of screening mammograms result in biopsy, and approximately 70% of these biopsies are benign. Decreasing the number of unnecessary biopsies would be cost effective and decrease patient anxiety about breast cancer screening. We evaluated a quantitative CAD algorithm that differentiates benign and malignant calcifications and compared these results to those of experienced radiologists in selecting cases for biopsy. The algorithm is based on a combined use of artificial intelligence (deep learning) and physics based mathematical classifiers that makes predictions of suspiciousness through quantitative scoring.

METHOD AND MATERIALS

In this IRB approved study, we performed a comparative analysis on patients' screening and diagnostic 2D mammograms where tissue was sent to biopsy based on suspicious calcifications detected by MQSA certified breast radiologists. 10,500 consecutive cases from 3 different institutions were reviewed. These images were evaluated with a quantitative CAD (qCAD) that employs deep learning (DL), a form of artificial intelligence (AI) to make predictions of suspiciousness of mammographic findings. These predictions were compared to the expert radiologists' reads. The DL embedded in the algorithm is an analytical function determined by the training datasets that mathematically define both malignant and benign calcifications.

RESULTS

Of the 391 cases sent to biopsy, 302 cases were benign and 89 malignant (including DCIS). The algorithm detected 100% of confirmed cancer cases. If biopsy recommendations had been based on the algorithm up to 56% of biopsies could have been avoided.

CONCLUSION

This CAD algorithm trained with AI can potentially reduce the number of unnecessary biopsies based on suspicious calcifications by up to 56%. The qCAD was more accurate than the radiologists at classifying breast calcifications on mammography.

CLINICAL RELEVANCE/APPLICATION

The use of artificial intelligence in mammography may be useful in reducing false positive breast biopsies and to enhance more accurate detection of breast malignancies. This is likely to lead to health savings costs as well as eliminate pain and distress for many patients.

SSK01-07 Flat Epithelial Atypia Upgrade Rate

Wednesday, Nov. 29 11:30AM - 11:40AM Room: E450A

Participants
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PURPOSE

Flat epithelial atypia (FEA) is a controversial breast lesion whose optimal management with surgical excision versus imaging follow

Flat epithelial atypia (FEA) is a controversial breast lesion whose optimal management with surgical excision versus imaging follow-up is unknown. Widespread implementation of screening mammography programs has resulted in an increased detection of FEA. This study aims to determine the likelihood of upgrade to ductal carcinoma in situ (DCIS) or invasive carcinoma in individuals diagnosed with FEA at stereotactic needle biopsy. In addition, the relationship between family history of breast cancer and likelihood of upgrade is explored.

METHOD AND MATERIALS

Stereotactic biopsies were performed primarily for the assessment of microcalcifications seen on mammography. Initially these were done with 12G core needles, but vacuum devices (10 and 9G) are now the standard. FEA diagnoses were correlated with subsequent excisional biopsy pathology results or imaging follow-up. Patients were included only if there was no concomitant diagnosis of other high-risk lesion, papillary lesion, in-situ or invasive carcinoma. Surgical pathology or follow-up imaging was obtained for 623 patients. Upgraded cases were defined as diagnosis of DCIS or invasive carcinoma at surgery. Additionally, medical charts of women diagnosed with FEA were reviewed for family history of breast cancer.

RESULTS

An upgrade rate of 1.8% (11 lesions in 623 patients; 95% CI, 1.0%-3.2%) is reported. The remaining samples (612/623) had a surgical diagnosis of FEA or ADH, lobular carcinoma in situ, a benign finding with no atypia, or stable follow-up imaging. There is no significant association between family history of breast cancer and upgrade in preliminary results (OR 1.7; 95% CI, 0.39-6.61).

CONCLUSION

The upgrade rate of FEA diagnosed at CNB or VAB at our institution was 1.8%, which is at the low end of the range reported in the literature. Each facility should audit their upgrade rate before implementing a change in practice pattern.

CLINICAL RELEVANCE/APPLICATION

These results indicate that it is reasonable at our institution to avoid surgery in favor of short-term imaging follow-up for the majority, especially when there is no family history of breast cancer.

SSK01-08 Management of Lobular Neoplasia (Atypical Lobular Hyperplasia and Lobular Carcinoma in Situ) on Core Needle Biopsy Performed for Calcifications Using Precise Radiologic-Pathologic Correlation

Wednesday, Nov. 29 11:40AM - 11:50AM Room: E450A

Participants
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PURPOSE

To determine if there is a difference in upgrade rate of calcified vs incidental lobular neoplasia (LN) found on core biopsy performed for evaluation of suspicious calcifications.

METHOD AND MATERIALS

The study (approved by our institutional review board) included consecutive patients who underwent core needle biopsy from December, 2009 through December, 2016 directed at suspicious calcifications with results showing LN as the highest-risk lesion. Patients with concurrent atypical ductal hyperplasia, flat epithelial atypia, radial scar, papillary lesion, phyllodes tumor, ductal carcinoma in situ (DCIS), invasive ductal carcinoma (IDC), or invasive lobular carcinoma (ILC) on core were excluded. An upgrade was defined as surgical excisional pathology showing DCIS, IDC or ILC.

RESULTS

Three hundred fifty patients underwent successful core needle breast biopsy showing LN during the study period. Of these, 80 patients had LN as the highest-risk lesion. In sixty-two patients (78%), LN was an incidental histologic finding, and the targeted calcifications were associated with variety of benign concordant entities. In 17 patients (21%), calcifications were an intrinsic part of the LN lesion. Fifteen of those 17 patients (88%) underwent surgical excision, with an upgrade rate of 27% (4/15). Of the 62 patients who had incidental, non-calcified LN, 36 underwent surgical excision, with an upgrade rate of 2.7% (1/36). One patient with incidental LN was felt to have discordant rad-path results; excision showed invasive cancer. Of those with long term follow-up rather than excision, none have developed cancer (avg. length of follow-up =28 months).

CONCLUSION

Careful radiologic-pathologic correlation is needed to determine the appropriate management of lobular neoplasia. Women with core needle biopsy for calcifications that show incidental, non-calcified LN have small rate of upgrade and may not require excisional biopsy. However, surgical excision should be offered to women who have LN associated with calcifications.

CLINICAL RELEVANCE/APPLICATION

Management of LN remains controversial with recommendations ranging from imaging follow-up to mandatory surgical excision in all cases. Our data supports close radiologic-pathologic correlation and suggests that the calcified LN in core biopsy specimens has a greater likelihood of upgrade to cancer than incidental, non-calcified LN.

SSK01-09 Utility of Ultrasonography (US) and US-guided Fine-Needle Aspiration Biopsy for Axillary Staging in Early Breast Cancer: Is the US Diagnosis for Metastatic Lymph Nodes Useful?

Wednesday, Nov. 29 11:50AM - 12:00PM Room: E450A

Participants
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PURPOSE

To evaluate the accuracy of ultrasonography (US) and US-guided fine-needle aspiration biopsy (FNAB) for diagnosing metastatic invasion of the axilla in early breast carcinoma patients and to determine the usefulness of the US diagnosis for axillary staging.

METHOD AND MATERIALS

We retrospectively reviewed data on 2731 patients who were diagnosed as early breast cancer less than T2 stage from January 2006 to December 2015. All included patients underwent preoperative axillary US for axillary staging and US-guided FNAB was performed if lymph nodes showed any suspicious findings as follows: even or uneven cortical thickening, compressed fatty hilum, hypoechoic mass with loss of hilum. US and FNAB findings were compared using sentinel lymph node biopsy (SLNB) and axillary lymph node dissection (ALND) data.

RESULTS

Of 2731 patients, 446 (16.3%) showed suspicious nodes on US and underwent US-guided FNAB. Of these 446 patients, 202 (45.3%) showed positive findings, 244 (54.7%) showed negative findings on FNAB. The sensitivity, specificity, positive predictive value, and negative predictive value of US for pathologic proven metastatic lymph node were 30.4%, 88.2%, 45.3%, and 79.7%, respectively. The sensitivity, specificity, positive predictive value, and negative predictive value of US-guided FNAB were 62.4%, 93%, 88.1%, and 74.9%, respectively.

CONCLUSION

Axillary US and US-guided FNAB in early breast cancer showed relatively low rate of sensitivity. If axillary lymph nodes with suspicious US feature has been found in early breast cancer patients, axillary metastases will not be likely compared with the breast cancer patients with high tumor stage.

CLINICAL RELEVANCE/APPLICATION

In early breast cancer patients, the usefulness of axillary US for axillary staging could be lower than advanced breast cancer patients.

SSK02

Science Session with Keynote: Breast Imaging (Deep Learning, Quantitative Imaging and Big Data)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: E451A

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AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

Maryellen L. Giger, PhD, Chicago, IL (*Moderator*) Stockholder, Hologic, Inc; Stockholder, Quantitative Insights, Inc; Shareholder, QView Medical, Inc; Co-founder, Quantitative Insights, Inc; Royalties, Hologic, Inc; Royalties, General Electric Company; Royalties, MEDIAN Technologies; Royalties, Riverain Technologies, LLC; Royalties, Mitsubishi Corporation; Royalties, Toshiba Medical Systems Corporation
Despina Kontos, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSK02-01 Breast Keynote Speaker: Overview of Deep Learning and Breast Imaging

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SSK02-02 Detecting Breast Cancer in Mammography: How Close Are Computers to Radiologists?

Wednesday, Nov. 29 10:40AM - 10:50AM Room: E451A

Participants
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PURPOSE

To compare the performance of a commercial deep learning computer detection system to radiologists' performance in detecting breast cancer on digital mammography (DM) images.

METHOD AND MATERIALS

Six radiologists (22 years median experience with DM, range 3-44) retrospectively reviewed 155 unilateral two-view DM exams (73 malignant and 82 negatives, of which 42 were biopsy-proven benign lesions, and 40 normal cases defined as BIRADS 1 or 2 with one year follow-up). DM exams were scored on mammography displays using standard reading conditions. For all lesions, a level of suspiciousness score was given (0 - no lesion, 1 definitely benign - 10 definitely malignant). The highest score was used as the overall exam score. A commercially available computer system based on deep learning technology (Transpara 1.2.0, ScreenPoint Medical, Nijmegen, the Netherlands) was applied to the same dataset. This multi-vendor system automatically identifies soft-tissue and calcification lesions and combines the findings of all available views into a single cancer suspiciousness score (same scale as the readers, 0-10). Analysis was performed using Dorfman-Berbaum-Metz Multiple-Reader Multiple-Case mixed model analysis of variance, both including and excluding benign lesions in the negative class. Receiver operating characteristics area under the curve (AUC) and its 95% confidence intervals were used for comparison.

RESULTS

Averaged across radiologists, AUC was 0.83 (CI: 0.76-0.90) when evaluating the whole dataset, while for the deep learning system

Averaged across radiologists, AUC was 0.83 (CI: 0.79-0.90) when evaluating the whole dataset, while for the deep learning system the AUC was 0.79 (CI: 0.72-0.86) (p=0.378). The system did not perform statistically different than any of the readers (reader AUC range: 0.77-0.87, p>0.064). When benign lesions were excluded from the analysis, AUC was 0.90 (CI: 0.85-0.96) and 0.88 (CI: 0.84-0.94) for the radiologists and the computer system (p=0.576), respectively.

CONCLUSION

For the task of detecting breast cancer in DM, the performance of a deep learning computer system is not statistically different from the average performance of 6 radiologists, even though the AUC for radiologists was still slightly higher.

CLINICAL RELEVANCE/APPLICATION

Computer systems with similar clinical performance as radiologists could be used, for instance, as double reading, to automatically discriminate normal cases, or to shorten reading time.

SSK02-03 Differentiating Between Malignant and Benign Masses at Breast US: Improving Radiologists' Diagnostic Performances Using Computer-Aided Diagnosis System Based on Deep Learning Algorithm

Wednesday, Nov. 29 10:50AM - 11:00AM Room: E451A

Participants
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PURPOSE

To compare performances of computer-aided diagnosis (CAD) system based on deep learning algorithm and radiologists in differentiating between malignant and benign masses at breast ultrasound (US) and to determine whether CAD system could improve the radiologists' performances

METHOD AND MATERIALS

This prospective study was conducted with institutional review board approval. B-mode US images were obtained for 253 breast masses (173 benign, 80 malignant) in 226 concesutive women. US findings of the breast masses were retrospectively analyzed by CAD system (S-DetectTM) and four radiologists. In predicting malignancy, CAD system results were dichotomized (possibly benign vs. possibly malignant). The radiologists independently assessed the Breast Imaging Reporting and Data System (BI-RADS) final assessments for two data sets: US alone, and US with CAD system results. Final assessments of the radiologists were categorized into positive (category 4a or higher) and negative (category 3 or lower) for each data set. Diagnostic performances of CAD system and the radiologists for two data sets were compared.

RESULTS

CAD system showed significantly higher values in accuracy, specificity, and positive predictive value (PPV) ($P<0.01$), and similar sensitivity ($P>0.05$) compared to those of the three radiologists, but the differences in the corresponding values between CAD system and the one radiologist were not significant. When CAD result was added to US, the three radiologists showed significant improvement in accuracy, specificity, and PPV, without significant change in sensitivity and negative predictive value, but the one radiologist showed no significant change in diagnostic values.

CONCLUSION

Diagnostic performance of CAD system was higher than or comparable to those of raiologists in differentiating between malignant and benign masses at breast US. Using CAD system may improve the accuracy, specificity, and PPV of the raiologists without loss in sensitivity.

CLINICAL RELEVANCE/APPLICATION

CAD system based on deep learning algorithm can improve the radiologists' diagnostic performances in differentiating between malignant and benign masses at breast US.

SSK02-04 Advanced Data-Driven Imaging Biomarker for Breast Cancer Screening in Mammography

Wednesday, Nov. 29 11:00AM - 11:10AM Room: E451A

Participants
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PURPOSE

Previously, we demonstrated data-driven imaging biomarker in mammography (DIB-MG; an imaging biomarker derived from large-scale mammography data by using deep learning technology) for classification of cancer and normal. Now, we assess the feasibility

of DIB-MG including cancer, normal, and benign exams and evaluate its potential for detection of malignant lesion.

METHOD AND MATERIALS

We collected 37,185 (set-A) and 7,101 (set-B) exams of 4 view digital mammograms from two institutions. For cross-institution validation, we used set-A for training DIB-MG and set-B for evaluating the trained model. Set-A consists of 1,019 cancer, 17,346 normal, and 18,820 benign exams, and set-B consists of 1,987 cancer, 2,982 normal, and 2,132 benign exams. DIB-MG is trained based on deep convolutional neural networks (CNNs). Entire training process is divided into two stages; multi-scale patch-based pre-training followed by image-based fine-tuning with semi-supervised segmentation. Total 128,960 malignant, 252,395 benign, and 200,000 normal patches were densely extracted from four scales of original images. Malignant and benign lesions were finely annotated by radiologists for patch extraction. In the image-based fine-tuning, parameters of initial convolutional layers were fixed and the rest convolutional layers were tuned based on all of 37,185 exams. During training, cancer probability of each exam is compared with the ground-truth diagnosis result, and the error between the prediction and the ground-truth label is propagated backward to optimize parameters in all layers except for the fixed one. Trained DIB-MG predicts the cancer probability of the input exam as well as a DIB map which includes the most probable locations of abnormalities.

RESULTS

AUC was 0.814. Sensitivity (specificity) according to different thresholds for the test set is: 0.764 (0.692), 0.621 (0.924), 0.549 (0.957) with respect to the thresholds 0.1, 0.3, 0.5. An exemplary DIB map is described in Fig.1.

CONCLUSION

This research showed the potential of DIB-MG as a screening tool for breast cancer through the cross-institution evaluation. Further clinical study of DIB-MG is needed for using it as a reliable screening tool for breast cancer.

CLINICAL RELEVANCE/APPLICATION

With further clinical studies, DIB-MG can be practically used as a second-reader in order to help radiologists diagnosing breast cancer and detecting malignant lesions.

SSK02-05 A Predictive Deep Learning Model to Determine the Presence of Breast Cancer on Screening and Diagnostic Mammograms

Wednesday, Nov. 29 11:10AM - 11:20AM Room: E451A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Nearly one in eight U.S. women will develop breast cancer in their lifetimes. Mammography is a safe and effective screening tool; however, it suffers from high recall and biopsy rates, which are costly and traumatic to the patient. The use of deep learning has the potential to improve accuracy, thereby decreasing both the recall and biopsy rate.

METHOD AND MATERIALS

136,253 mammographic accessions corresponding to 755,945 DICOM files were extracted from the radiology picture archiving and communication system (PACS). DICOMs were filtered to include only screening and diagnostic studies and standard, non-magnification views, which resulted in 127,329 accessions corresponding to 660,989 DICOMs. 33,342 pathology reports and 93,727 BI-RADS scores were then extracted from their respective databases for ground truth labeling of DICOM images. Regular expression technique with manual validation was used to assign final pathologic diagnosis to a pilot subset of DICOM files based upon positive pathology results within one year. This was combined with BI-RADS 1, 2, and 6 cases, resulting in 4,738 cases labeled as cancer and 354,837 cases labeled as non-cancer. A deep learning model based on the Inception v3 architecture with pre-trained weights from the Imagenet dataset using the Keras API with TensorFlow backend was fine-tuned on 2,569 cancer and 5,105 non-cancer images at 299 x 299 resolution.

RESULTS

The model achieved an area under the receiver operating characteristic curve (AUC) of 0.83 when predicting on an internal test set of 200 cancer and 200 non-cancer images. Interestingly, on a subset of 50 positive and 50 negative BIRADS-2 cases, the model also achieved an AUC of 0.83, surpassing human readers. When tested on an external validation set of 2000 images with composition reflecting a more clinically accurate prevalence of cancer to non-cancer, i.e., 1% cancer and 99% non-cancer, the model achieved an AUC of 0.96.

CONCLUSION

Deep learning may be an effective tool for detecting breast cancer in mammograms, however training and validation with larger data sets is required. Results may also improve with higher resolution, however this requires modification of existing models and

increased hardware capacity.

CLINICAL RELEVANCE/APPLICATION

Deep learning in mammography has the potential to detect breast cancer using features not yet recognized by human readers, thereby improving accuracy and decreasing false positives.

SSK02-06 Automated Breast Cancer Risk Assessment from FFDM Images

Wednesday, Nov. 29 11:20AM - 11:30AM Room: E451A

Participants
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PURPOSE

To automatically evaluate future breast cancer risk by computerized analysis of full-field digital mammography (FFDM) images.

METHOD AND MATERIALS

This IRB-approved study included a total of 407 GE FFDM images (12-bit dynamic range). Cases comprised 131 women who underwent screening mammography and were subsequently diagnosed with breast cancer within an average of 2.8±2.4 years. Controls comprised 276 women who did not develop breast cancer over up to 10 years of follow-up screening mammography. We extracted 99 grayscale and texture features such as Haralick and wavelet features, from patches in the CC view of the unaffected breast for cases and LCC view for controls. We applied a Bag of Visual Words method to build the histogram of image features for each breast, and used a random forest classifier to predict case or control status based on the histograms, age, race/ethnicity, menopausal status, parity and body mass index. We evaluated performance using ten-fold cross validation and computed the Area Under the ROC Curve (AUC).

RESULTS

Our method showed better discrimination between cases and controls (AUC, 0.84; 95% CI, 0.81-0.85), than other common techniques such as BIRADS (0.66; 0.62-0.74), Cumulus (0.64; 0.6-0.68), Libra (0.62; 0.55-0.65) and Volpara (0.62; 0.56-0.67). In contrast to these common methods that quantify only the absolute or percentage of dense tissue, we found that the additional image features extracted from non-dense tissue improved the AUC by 0.03 ($p<0.05$).

CONCLUSION

Our method shows promising results for risk evaluation of future breast cancer. Our novel technique is significantly better than using only area/volume/percentage of breast density, as is done by state of the art methods. Importantly, informative image features are located in both dense and non-dense breast regions.

CLINICAL RELEVANCE/APPLICATION

Our tool can automatically deliver a novel, validated imaging-based risk score to improve the accuracy and reliability of breast cancer risk prediction directly from digital screening mammography.

SSK02-07 Standard-Dose versus Synthetic Digital Mammograms: Are There Differences in Automated Measurements of Breast Parenchymal Patterns?

Wednesday, Nov. 29 11:30AM - 11:40AM Room: E451A

Participants
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PURPOSE

Breast parenchymal pattern measures have demonstrated substantial potential in breast cancer risk assessment. However, as synthetic 2D mammograms (sDMs) are increasingly being used to reduce dose when screening is performed with digital breast tomosynthesis, standard-dose mammograms (DMs) that have widely been used to evaluate breast parenchymal patterns may no longer be acquired. We investigate differences in quantitative parenchymal pattern measures from DMs versus sDMs.

METHOD AND MATERIALS

We retrospectively analyzed 7365 pairs of bilateral "FOR PRESENTATION" DMs and synthetic ("C-View") images corresponding to 3698 women with negative (BI-RADS 1 or 2) routine screening evaluation. Images were acquired with a Selenia Dimensions system (Hologic Inc.) over a 4-month period at our institution for which both DMs and sDMs were available for each screening exam. For each image, 26 established parenchymal pattern descriptors were automatically estimated, including gray-level histogram, co-

occurrence, run-length, and fractal dimension texture features. Feature measurements were compared using paired Wilcoxon signed-ranks tests and Spearman correlation (r). We also compared feature correlations with automated breast percent density (PD) estimates, and evaluated the within woman intraclass feature correlation (ICC) for the two mammogram types.

RESULTS

Most features were strongly (r>0.6 for 12 features) or moderately (0.4<= r<=0.6 for 11 features) correlated between DMs and sDMs. However, all measurements were significantly different between the two mammogram types (Wilcoxon test, p<0.001). Regardless of the mammogram type, parenchymal texture measures demonstrated weak to moderate correlations with breast PD (-0.6<=r<=0.6) and strong bilateral symmetry (ICC>=0.6), with significantly increased ICC values for sDMs (average ICC = 0.80 vs average ICC = 0.67, p=0.0003).

CONCLUSION

Breast parenchymal pattern measurements extracted from sDMs are different, yet correlated with those made from DMs. Furthermore, in either mammogram type, there is an inherently strong agreement in bilateral parenchymal symmetry for the extracted texture measures capturing information complementary to the established risk factor of breast density.

CLINICAL RELEVANCE/APPLICATION

Our findings may contribute to integrating computerized parenchymal complexity analysis for breast cancer risk assessment in clinical settings where DMs may be fully replaced by synthetic mammograms.

SSK02-08 Mammographic Parenchymal Analysis with Deep Belief Network for Breast Cancer Risk Prediction

Wednesday, Nov. 29 11:40AM - 11:50AM Room: E451A

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PURPOSE

To develop a quantitative mammographic parenchymal pattern (MPP) descriptor for breast cancer risk prediction using digital mammograms (DM).

METHOD AND MATERIALS

With IRB approval, we performed a matched case-control study to investigate the use of MPP for breast cancer risk prediction. We retrospectively collected data of 398 subjects including 199 paired cancer cases and cancer-free controls. The controls were frequency matched to the cases with respect to the years of screening, age, and race. The screening DMs in the year of cancer diagnosis and up to 5 years of consecutive prior screening DMs were collected for each subject. A total of 2712 CC-views were analyzed in this study. The "for processing" image was first processed by a multiscale method to enhance the fibroglandular densities and parenchymal patterns. Locations of keypoints were identified by a scale-invariant feature transform algorithm. Three ROIs were automatically localized based on the keypoint distribution and used for MPP analysis. The MPP descriptor was formed by a semi-supervised learning scheme, in which an unsupervised deep belief network (DBN) with tied weights was used as MPP feature generator. Layer-wise neurons with ReLU as activation function was first pretrained and then stacked to construct the DBN. The cross-entropy error with *L*2 norm was minimized by an optimization algorithm based on adaptive estimates of lower-order moments. A random forest was then trained to combine the MPP features and estimate the probability of cancer risk. Ten-fold cross validation was used for model selection and evaluation. ROC analysis was performed to assess the prediction accuracy.

RESULTS

The average age for cases and controls were 60.9±10.6 and 60.9±10.5, respectively. At the year of cancer diagnosis, the AUC was 0.78±0.01. The AUCs from 1-year to 5-year prior exams were 0.75±0.01, 0.70±0.01, 0.64±0.02, 0.59±0.02, and 0.61±0.02, respectively.

CONCLUSION

The MPP can differentiate cases from matched controls and the changes in MPP increased as the time approached cancer diagnosis. Our proposed MPP by machine learning shows promise for cancer risk prediction. Future work is underway to enlarge the data set and to improve the machine learning scheme.

CLINICAL RELEVANCE/APPLICATION

Our MPP analysis on screening DMs shows potential for breast cancer risk assessment and the change in risk over time, which may be useful for personalizing screening regimen and early detection.

SSK02-09 Automatic Identification of Nuanced Imaging Features in Recalled but Biopsy Benign Mammogram Images

Wednesday, Nov. 29 11:50AM - 12:00PM Room: E451A

Awards
Trainee Research Prize - Fellow

Participants
Sarah S. Aboutalib, PhD, Pittsburgh, PA (*Presenter*) Nothing to Disclose

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PURPOSE

In digital mammography screening, a main concern is to reduce false recall rates. In this study, we investigate automatic identification of nuanced imaging features to distinguish mammogram images belonging to negative, recalled-benign, and positive cases, aimed to better interpret recalled images with biopsy benign results.

METHOD AND MATERIALS

A retrospective study was performed on a cohort of 1303 patients (5212 mammogram images) who underwent standard digital mammography screening (2007-2014): 552 patients were evaluated as negative in the initial screen, maintaining the cancer-free status in at least a one-year follow-up; 376 patients were recalled and eventually determined to be biopsy-proven benign based on pathology results; 375 patients were evaluated as positive for breast cancer (27% DCIS; 73% Invasive) based on pathology results. Both craniocaudal (CC) and mediolateral oblique (MLO) image views were used for all patients; for the positive cancer cases, only images of the cancer-affected breasts were included. A fully automated computerized method utilizing deep learning with a convolutional neural network was applied to distinguish between the three categories listed above (four binary-class comparisons plus one triple-class comparison). To enhance training of the deep learning network, transfer learning from a large existing imaging database was used followed by fine-tuning with the mammogram images. The receiver operating characteristic (ROC) was generated and the area under the curve (AUC) was calculated as a metric of the classification accuracy.

RESULTS

Full results of all five scenarios are shown in the figure. In all comparisons, the three categories (negative, recalled-benign, and positive) can be distinguished (AUC ranging from 0.66 to 0.81) by automatically identified mammographic imaging nuances. The identified imaging features between recalled-benign and negative are most distinguishing (AUC=0.81), followed by recalled-benign vs. positive (AUC=0.75).

CONCLUSION

Nuanced mammographic imaging features identified by automatic deep learning methods on a large imaging cohort distinguish negative, recalled-benign, and positive cases.

CLINICAL RELEVANCE/APPLICATION

Automatic learning coupled with the distinguishing mammographic imaging nuances can lead to a computerized toolkit to potentially help better interpret recalled-benign images to reduce false recalls.

SSK03

Cardiac (Coronary Artery Disease: Plaque and Calcium)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S502AB

CA CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Jens Bremerich, MD, Basel, Switzerland (*Moderator*) Nothing to Disclose
Jadranka Stojanovska, MD, MS, Ann Arbor, MI (*Moderator*) Consultant, Guerbet SA

Sub-Events

SSK03-01 Effect of Energy Difference in the Evaluation of Calcification Size and Luminal Diameter in Calcified Coronary Artery Plaque Using Spectral CT

Participants
Hiroto Yunaga, Yonago, Japan (*Presenter*) Nothing to Disclose
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PURPOSE

Coronary artery calcification degrades diagnostic accuracy on the evaluation of coronary artery stenosis. It is known that virtual monochromatic image (VMI) at high energy level using dual-energy CT (DECT) reduces blooming artifacts. The aim of our study was to evaluate the calcium blooming effect and the differences of luminal diameter in varying VMI energy using rapid kilovolt switching single-source dual-energy CT (ssDECT).

METHOD AND MATERIALS

We evaluated 45 calcified plaques in 31 patients with suspected coronary artery disease. Coronary artery calcifications were evaluated based on vessel cross-sectional images from 40 to 140 keV in both pre-contrast and contrast-enhanced coronary CT angiography (CCTA) with ssDECT. We measured the diameter of calcifications on non-contrast CT and coronary artery lumens on CCTA using the full-width half maximum method. The calcium blooming effect was evaluated on pre-contrast VMIs. The diameter of calcifications on non-contrast CT and coronary arterial lumens on CCTA in each keV were compared with that of 70 keV VMI that had an equal effective energy of 120kVp as a reference standard.

RESULTS

Only 40 keV VMI showed significantly large calcification diameter than that of 70 keV image (1.53±0.37mm vs. 1.48±0.33mm, $p<0.01$) on the pre-contrast scan. Meanwhile, the other keV images did not show significant differences in diameter compared to that of 70keV VMI. Regarding coronary artery luminal diameter, no significant differences were observed among all energy levels compared to that of 70keV VMI (40keV, 2.47±0.67mm; 50keV, 2.47±0.67mm; 60keV, 2.50±0.67mm; 70keV, 2.48±0.68mm; 80keV, 2.48±0.68mm; 90keV, 2.48±0.67mm; 100keV, 2.49±0.67mm; 110keV, 2.51±0.66mm; 120keV, 2.49±0.68mm; 130keV, 2.49±0.67mm; 140keV, 2.48±0.68mm), on CCTA (all p=N.S).

CONCLUSION

The diameter of coronary artery calcification and the luminal diameter of the coronary artery with calcified plaque would not be changed in almost all VMIs.

CLINICAL RELEVANCE/APPLICATION

The difference of VMI energy would not affect the measurement of luminal diameter of the coronary artery with calcified plaque.

SSK03-02 The Impact of Advanced Modeled Iterative Reconstruction Strength Level on the Image Quality of Calcified Coronary Segments in Coronary CT Angiography

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S502AB

Participants
Yuanding Wang, Beijing, China (*Presenter*) Nothing to Disclose
Xiangying Du, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Kuncheng Li, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To determine the value of advanced model-based iterative reconstruction (ADMIRE) on improving the image quality of coronary CT angiography (CCTA) in coronary segments with/without calcified plaques, by evaluating the image quality at different levels of ADMIRE in comparison with that at filtered back projection (FBP) on a third-generation dual source CT scanner.

METHOD AND MATERIALS

CCTA was performed on a third-generation, dual-source CT with automated tube voltage adaptation. Patients with coronary artery disease and at least one calcified segment on calcium scoring scan were enrolled. Image series were reconstructed with FBP and ADMIRE (strength levels 1 - 5), respectively. Attenuation, image noise, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) were calculated, the volume of the calcified plaques were measurd. Subjective image quality criteria was assessed by two observers using a 5-point Likert scale.

RESULTS

Results: There were no statistically significant differences in attenuation between each ADMIRE group (strengths 1 - 5) and FBP group ($p > 0.05$). Image noise decreased significantly using ADMIRE compared with FBP and was reduced with increasing ADMIRE strength levels (maximal reduction, 45.4%, $p < 0.05$). The CNR and SNR of each ADMIRE group were significantly higher than those of FBP group, increasing with higher ADMIRE strength levels ($p < 0.05$). The volume of calcified plagues were decreased with the increasing ADMIRE strength levels($p<0.05$). Both in segments with calcified plaques and without calcification, subjective image quality was rated best at ADMIRE 4, followed by ADMIRE 5, ADMIRE 3, ADMIRE 2, ADMIRE 1, and FBP.

CONCLUSION

Image quality of CCTA can be significantly improved by the application of ADMIRE, both in coronary segments with and without calcified plaques, while the optimal image quality was achieved at iterative strength level 4.

CLINICAL RELEVANCE/APPLICATION

By increasing the image quality and decreasing the blooming artifacts, the high strength level IR technique decreases the need for unnecessary coronary catheterization or myocardial perfusion studies.

SSK03-03 Coronary Artery Enhancement for Coronary CT Angiography and Plaque Analysis: Optimization with a Test Bolus and Contrast Dilution Protocol

Wednesday, Nov. 29 10:50AM - 11:00AM Room: S502AB

Participants
Veit Sandfort, MD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose
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Rolf Symons, MD, Bethesda, MD (*Presenter*) Nothing to Disclose
Marissa Mallek, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose
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David A. Bluemke, MD, PhD, Bethesda, MD (*Abstract Co-Author*) Research agreement, Siemens AG; Research support, Siemens AG; Research agreement, Carestream Health, Inc; Research support, Carestream Health, Inc

PURPOSE

Quantification of total coronary plaque index and coronary artery stenosis is markedly affected by attenuation levels of the coronary lumen due to partial volume averaging. Thus, achieving consistent attenuation level of the coronary artery lumen improves quantitative analysis when comparing patient studies. We studied three contrast injection protocols for coronary CT angiography (CCTA) and compared both mean levels and standard deviation of contrast enhancement.

METHOD AND MATERIALS

We evaluated a test-bolus injection protocols in comparison to a weight-based injection (body weight (BW) <60 kg: 50 mL contrast, BW >= 60 kg and BW <= 100 kg: 60 mL contrast and BW > 100 kg: 70 mL, 5 ml/sec, imaging trigger by bolus-tracking). The test bolus injection consisted of injection of 75 ml of diluted contrast (30% iopamidol 370, 4.5 ml/sec) as test bolus. The test bolus peak attenuation was used for scan timing and calculation of the angiography bolus dilution. Aortic and coronary artery attenuation was measured and compared to a pre-defined target attenuation level (375 HU at 120 kVp equivalent).

RESULTS

Overall, 119 subjects were evaluated (66% men, age 62y, BMI 29, heart rate 56/min). The test-bolus guided injection protocol achieved the coronary target attenuation successfully and consistently (mean 373±39 HU, target 375 HU, relative standard deviation (rSD) 10.5 %); inter-study variation of the test-bolus method was significantly lower than that of the body weight injection protocol (mean 362±98, rSD 27%, $p<0.0001$, also see figure). A similar trend was seen for attenuation in the ascending aorta (rSD 9.4% vs. 30% for the test bolus protocol and the body weight protocol, respectively, $p<0.0001$). The timing was optimal (highest attenuation in ascending aorta compared with left atrium or descending aorta) in 73% of cases for the test-bolus protocol compared with 27% in the body mass guided injection protocol ($p<0.0001$).

CONCLUSION

A test-bolus guided injection protocol with variable contrast dilution allowed greatly improved standardization of coronary and aortic attenuation levels for coronary CT angiography.

CLINICAL RELEVANCE/APPLICATION

Consistent coronary lumen attenuation is desirable for plaque and stenosis quantification. A test-bolus guided contrast injection achieves improved consistency in coronary lumen attenuation.

SSK03-04 Half Dose CT Coronary Calcium Score: Impact of Iterative Reconstruction

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S502AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To evaluate the effectiveness of Iterative Reconstruction (IR) on the coronary artery calcium scores (CACS) by using a half radiation dose CT acquisition protocol compared to standard protocol.

METHOD AND MATERIALS

Based on a power analysis, this prospective study included 57 patients without known coronary artery disease who underwent two CACS acquisition (standard and half radiation dose) with MDCT (128-slice GE-VCT Hino W/VT 2000) within the same examination, following ethical permission. The standard protocol was acquired with tube voltage of 120 KVp and tube current of 170 mA, whereas the half dose protocol was acquired with 50% reduction of mA (85 mA) and the same tube voltage. Raw data of half dose protocols were reconstructed by using IR at all strength levels available, from 10% up to 100%, every 10%. Radiation dose as well as number of plaques, Agatston score, volume and mass were calculated and compared between the two protocols by using dedicated statistical test (Medcalc v17.4, Belgium). A p value <0.05 was considered statistically significant.

RESULTS

From an original population of 57 patients we exclude 6 patients for absence of coronary plaques, thus the final population comprised 51 patients (32 men and 19 women). The mean DLP were 45.447.10 and 21.663.24 for the standard and half dose protocol ($p<0.05$), respectively. The mean Agatston score for the standard protocol was 595.82±977.09 and 19.27±19.53 plaques were identified. No significant differences for Agatston score were observed between standard protocol and half dose protocol with IR at 40 and 50% (493.35±924.31 and 498.05±959.27, $p>0.05$), whereas significant differences were observed for all the remaining IR levels (all $p<0.05$). Moreover, no significant differences were calculated for the number of plaque with IR at 40% (23.67±21.46, $p>0.05$).

CONCLUSION

Half dose acquisition protocol with IR at 40% and 50% showed reliable results in terms of Agatston score for CACS showing no significan differences with standard protocol.

CLINICAL RELEVANCE/APPLICATION

Patients can benefit of half radiation dose CACS acquisition protocol with IR at 40%, which shows comparable results in the evaluation of Agatston score and number of plaques to the standard protocol.

SSK03-05 250 Micron Resolution Photon-Counting CT: Potential for Improved Imaging of Calcified Coronary Artery Stenoses

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S502AB

Participants
Veit Sandfort, MD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose
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Amir Pourmorteza, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose

PURPOSE

Coronary CT angiography using conventional CT leads to overestimation of calcified stenosis due to blooming / partial volume effects. The purpose of this study was to determine the potential utility of ultra-high resolution (UHR) (250 micron) photon-counting detector (PCD) CT using human ex-vivo hearts. We hypothesize that the increased resolution will reduce overestimation of calcified plaque stenosis when compared to (0.50 mm) standard resolution CT.

METHOD AND MATERIALS

We used a whole-body PCD CT scanner. Each PCD pixel consists of 4x4 subpixels whose photon counts are combined in standard resolution (SR) mode to create 0.50 mm isotropic pixels at isocenter. Recently, the system has been upgraded to allow 2x2 binning of subpixels making UHR CT possible with 0.25 mm isotropic pixels at isocenter. 5 human ex-vivo hearts were placed inside an anthropomorphic chest phantom and scanned in dose-matched SR and UHR modes at 140 kVp and 106 mAs. We measured the total cardiac calcium volume to evaluate the effect of higher resolution on calcium volume at a clinically used threshold of 130 HU at 140 kVp. All images were reconstructed with filtered backprojection. We assessed imaging of calcified stenosis in total of 18 coronary locations with at least semi-circumferential calcified plaques. We tested if a previously described method for inner vessel lumen detection based on the 2nd derivative of a cross-sectional Hounsfield Unit (HU) profile was able to detect a stenosed by patient coronary artery lumen.

RESULTS

Calcium volume was 10 % lower in UHR images compared with SR images (424 mm3 vs 469 mm3). Lumen detection rate was

significantly higher in UHR images compared to SR (18/18 [100%] vs. 11/18 [61%], Fisher's test P=0.0076). In addition, the detected lumen diameter was significantly larger in UHR compared to SR images (0.65 mm vs 0.60 mm, Wilcoxon P=0.02).

CONCLUSION

250 micron resolution photon-counting CT resulted in lower calcium volumes, likely reflecting less calcium blooming. It also resulted in larger lumen diameter measurements and enabled successful detection of the lumen in all calcified stenoses while standard resolution failed to depict the lumen in 39% of cases.

CLINICAL RELEVANCE/APPLICATION

One reason for false positive coronary CT angiography is calcium blooming in regions of stenosis. 250 micron photon counting CT may allow better lumen depiction of these difficult lesions.

SSK03-06 Who are the Patients Whose Coronary Artery Calcification Progresses Rapidly? According to Serial CT Measurements of Coronary Artery Calcium

Wednesday, Nov. 29 11:20AM - 11:30AM Room: S502AB

Participants
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Min Jae Park, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Coronary artery calcium (CAC) is an established surrogate marker for cardiovascular disease, but little is known about risk factors for the progression of calcium burden. This study assessed the pattern of CAC increment and risk factors for rapid CAC progression.

METHOD AND MATERIALS

515 asymptomatic adults who underwent serial CAC at least 3 times from 2004 to 2016 were included. The patients were categorized into three groups: zero CAC on all serial scans (group 1), eventual CAC formation with initially zero CAC (group 2), and increasing CAC with initial presence of CAC (group 3). Group 3 was subdivided into four groups according to the degree of slope and pattern (linear or exponential slope) of the CAC increment (Figure). Variable risk factors and blood chemistry were analyzed for the each group.

RESULTS

Group 1 (n=310, 60.2%), group 2 (n=59, 11.5%) and group 3 (n=146, 28.3%) were followed up for the mean period of 2760 days. Age, prevalence of male, hypertension, hyperlipidemia, diabetes medication, family history of ischemic heart disease, smoker, systolic and diastolic blood pressure, glucose and triglyceride were higher in the group 3 compared to the group 1 (all $p < 0.05$). There was no significant difference in any of the risk factor in between the groups with linear (n=63, 43.6%) and exponential slope (n=83, 56.8%). However, there were some risk factors that differed in between the high and low grade slopes, for both linear and exponential groups. In the linear slope group, prevalence of previous ischemic heart disease, hyperlipidemia, triglyceride, glucose, and HbA1c were higher for the group with high grade slope compared to the group with low grade slope (all $p < 0.05$). On the other hand, in the exponential slope group, initial CACS was higher for the group with high grade slope compared to the group with low grade slope ($p=0.03$).

CONCLUSION

Patients showed varying CAC progression with differing slope pattern and degree. Although there was no significant relationship of risk factors to the slope pattern (linear vs. exponential), some risk factors and initial CACS were related to the higher degree of slope of CAC progression.

CLINICAL RELEVANCE/APPLICATION

According to our study, appropriate follow up time for CAC measurement should be individualized, under consideration of each patient's risk factors as well as initial CAC score.

SSK03-07 Association between Serum Uric Acid and the Characteristics of Coronary Plaque Burden: Assessment with Coronary CT Angiography

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S502AB

Participants
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PURPOSE

It is controversial whether serum uric acid (UA) is an independent risk factor for cardiovascular diseases (CVD). The aim of this study was to investigate the correlation between the serum UA level and coronary plaque burden characteristics evaluated by coronary CT angiography (CCTA).

METHOD AND MATERIALS

In total, 1315 patients who underwent CCTA were divided into the hyperuricemia group and normal serum UA group according to

their serum UA level and stratified by gender. The low-attenuation plaque volume (LPV) and total plaque volume (TPV) were separately measured in each main coronary artery. The correlation of serum UA or hyperuricemia with coronary plaque burden was assessed using multivariate-adjusted logistic and linear regression analyses.

RESULTS

The TPV and LPV significantly differed between males and females ($P < 0.0001$ each). The TPV values were higher in female subjects with hyperuricemia than in subjects without hyperuricemia ($P = 0.0124$). The serum UA level significantly correlated with the TPV in both genders ($ß = 0.4231$ and $P = 0.0441$ for males and $ß = 0.4996$ and $P = 0.0149$ for females). However, the serum UA and LPV did not correlate with either gender after adjusting for multivariates.

CONCLUSION

The serum UA level was significantly associated with the coronary TPV in both genders. However, the serum UA was not associated with the LPV. We found that the serum UA may play an independent role in the pathophysiology of total plaque burden.

CLINICAL RELEVANCE/APPLICATION

We found that the serum UA plays an independent role in the pathophysiology of the total plaque burden, and we suggest controlling the serum UA level as a meaningful strategy in the management of coronary plaque burden.

SSK03-08 The Diagnosis of Coronary Plaque Stability by Multislice Computed Tomography Coronary Angiography

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S502AB

Participants
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PURPOSE

This study was to investigate and summarize the differential characteristics of non-calcified unstable coronary plaques and stable coronary plaques using MSCT.

METHOD AND MATERIALS

Sixty patients with coronary heart disease were included in our study. 37 unstable plaques and 31 stable plaques were identified. We analyzed the plaque CT attenuation, the napkin-ring sign, napkin-ring thickness, the plaque distribution, the degree of lumen stenosis and the sensitivity, specificity, positive predictive value, negative predictive value of MSCT to identify the plaque stability. The difference and correlation between MSCT and IVUS in the diagnosis of plaque characteristic were also analyzed. All statistical analysis was done using software Stata 10.0. The difference was statistically significant if $P<0.05$.

RESULTS

The average CT value of unstable plaques (29.7±19.4 HU)was lower than stable plaques (76.4±24.8 HU)($P<0.05$),although there was some overlap. The napkin ring sign was more frequently observed in unstable group(91.9%) than stable group (22.6%) ($P<0.05$). The median thickness of napkin-ring in unstable plaques(0.7mm) was thinner than stable plaques(1.1mm)($P<0.05$). The former had more severe lumen stenosis or occlusion (70.3%)than the latter (41.9%)($P<0.05$).The plaques were mainly distributed in the left anterior descending artery in both groups. The sensitivity,specificity,positive predictive value and negative predictive value of MSCT to confirm unstable plaques were 78.4%, 77.4%,80.6% and 75% respectively, While were respectively 77.4%,78.4%, 75% and 80.6% to confirm stable plaques. MSCT and IVUS had no statistically significant difference in the diagnosis of plaque characteristic($P>0.05$),while showed a correlation in the identification of plaque stability ($P=0.00$,$r=0.5568$).

CONCLUSION

The average CT attenuation of non-calcified unstable plaques was lower than stable plaques although there was some overlap. The incidence of napkin-ring sign in unstable plaques was significantly higher than that in stable plaques; Unstable plaques had more severe lumen stenosis or occlusion than stable plaques. MSCT demonstrated a clinical significance in the identification of coronary plaque stability.

CLINICAL RELEVANCE/APPLICATION

MSCT demonstrated a clinical significance in the identification of coronary plaque stability.

SSK03-09 The Evaluation of Subclinical Coronary Atherosclerosis of Different Therapy Stages in Middle-Aged HIV (+) Chinese Adults

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S502AB

Participants
Juan Huang, Zheng Zhou, China (*Presenter*) Nothing to Disclose
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PURPOSE

It is demonstrated that HIV (+) patients have a higher risk for cardiovascular disease, mainly due to HIV infection itself and medication side effect in addition to traditional risk factors. This study is aimed to determine whether the routinely long-term medication treatment using HAART has an impact on total CAC score and plaque formation.

METHOD AND MATERIALS

A total number of 120 HIV (+) patients (52 ± 4 years) was enrolled in the study, who underwent CCTA and besides, who was with normal kidney function and without the history of revascularization. According to the duration of HAART mediation treatment, the patients were divided into three groups: A (less than 2 years), B (2 to 5 years) and C (more than 5 years).

RESULTS

There were 40 patients in each group, and no significant differences in demographic data and risk factors of cardiovascular disease were found between groups. The median Agatston CCS for group A was 74 [25-75th percentile: 0-492], with a range from 0 to 4781;As for group B and group C, the median value was 79 [25-75th percentile: 0-502], with a range from 0 to 5120 and 111 [25-75th percentile: 0-532], with a range from 0 to 7320 respectively, the difference of Agatston CCS between groups were found statistically significant. The number of non-calcified plaques was 17 for group A, 29 for group B and, 33 for group C. And significant difference in the number of non-calcified plaque was also found between groups. The mean segments with plaque for different groups were 15, 23, and 27 respectively. And there was no significant difference found between groups.

CONCLUSION

It is indicated by this study that the longer duration of HAART medication therapy the patients received, the higher level of CAC score and higher incidence of non-calcified plaque would happen. However, larger sample is needed for further validation.

CLINICAL RELEVANCE/APPLICATION

The longer duration of HAART medication therapy the patients received, the higher level of CAC score and higher incidence of non-calcified plaque might happen.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSK04

Cardiac (General Topics, MRI)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S504AB

CA MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Charles S. White, MD, Baltimore, MD (*Moderator*) Consultant, Koninklijke Philips NV

Sub-Events

SSK04-01 Safety of MRI in Patients with Conditional or Non-Conditional Pacemaker or Other Implantable Cardiac Electronic Devices (ICED): A Systematic Review

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PURPOSE

To review the MRI safety in patients carrying a pacemaker or other ICEDs.

METHOD AND MATERIALS

A search was performed on March 2017 using MEDLINE/EMBASE for articles on the MRI safety in ICED carriers. Keywords included MRI, pacemaker, implantable cardioverter defibrillator, cardiac electronic device, safety, and adverse events (AEs). We extracted: number of patients, age, device dependency, field strength, specific absorption rate (SAR), studied body region, technical ICED parameters, and follow-up time.

RESULTS

Of 493 articles, 53 were analyzed for a total 6,237 exams in 5,394 patients. Design was prospective in 49 (4 randomized). Devices were MRI non-conditional in 32 studies (2,889 patients), conditional in 16 (1,708 patients), mixed in 5 (797 patients). Patients were device-dependent in 1 study, independent in 22, mixed in 18, and not defined in 12. Field strength was 0.2T in 1 study, 0.5T in 3, 1.5T in 45, 2T in 1, 3T in 2, mixed in 1. The studied body region was thoracic in 27 studies, non-thoracic in 16, and mixed in 10. SAR was limited in 39 studies, not limited in 5, not reported in 9. Follow up was 0-6 months in 32 studies, >6 months in 6, and not reported in 15. No fatal events occurred. Five studies reported clinically relevant AEs: atrial arrhythmias (6 patients), intolerable heating (5 patients), perforation (4 patients), lead dislodgements (3 patients), and generator failure with immediate replacement (1 patient), for a total of 19 AEs, 7 in patients with MRI conditional ICED, 9 in patients with non-conditional, and 3 in patients with an undefined ICED, for a total of 19 clinically relevant AEs. Twenty studies reported technical AEs, mainly power-on reset and battery voltage reduction. Two studies showed significant changes of atrial sensing, 4 of ventricular sensing, 3 of atrial pacing capture threshold (PCT), 4 of ventricular PCT, 6 of atrial lead impedance, 7 of ventricular lead impedance, and 9 of battery voltage.

CONCLUSION

Considering 6,237 MRI exams in 5,394 device-dependent or non-dependent carriers of conditional or non-conditional ICED, a very low rate of clinically relevant AEs was reported. The risk/benefit ratio is largely positive, also for non-conditional ICED.

CLINICAL RELEVANCE/APPLICATION

Patients carrying ICED should not be denied thoracic or nonthoracic MRI a priori, included patients with non-conditional devices. MRI may be performed safely under controlled conditions.

SSK04-02 Diagnostic Performance of Minimally Invasive Autopsy for Detection of Ischemic Heart Disease

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S504AB

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PURPOSE

In this study we investigated the performance of minimally invasive autopsy (MIA) to diagnose ischemic heart disease in clinically deceased patients

METHOD AND MATERIALS

In 99 adult cases with written consent for conventional autopsy (CA) and MIA, diagnostic accuracy of MIA and CA was calculated for acute and chronic myocardial ischemia. MIA consisted of total-body postmortem MR (PMMR) and CT (PMCT), combined with CT-guided biopsies of myocardial lesions. PMMR and PMCT were independently read by two radiologists with expertise in cardiac radiology. Calcium score (Agatston) and ROC curve for the prediction of acute and chronic ischemia were calculated for each case. CA including macroscopy and microscopy was the gold standard.

RESULTS

CA detected 34 cases of acute ischemia. Sensitivity of PMMR for acute ischemia was 0.50 (CI: 0.33-0.67) and specificity was 0.92 (CI: 0.86-0.99). PMMR combined with biopsy improved sensitivity to 0.97 (CI: 0.91-1.00) and specificity to 0.95 (CI: 0.9-1.00). CA detected 40 cases of chronic ischemia. Sensitivity of PMMR for chronic ischemia was 0.35 (CI: 0.20-0.50) and specificity was 1.00. PMMR combined with biopsy improved sensitivity for chronic ischemia to 0.90 (CI: 0.81-0.99) but specificity was lowered to 0.75 (CI: 0.63-0.86). Calcium score was a fair predictor for chronic ischemia (AUC=0.73, $p<0.001$), but a poor predictor for acute ischemia (AUC=0.61, $p=0.073$).

CONCLUSION

MIA shows high diagnostic accuracy for detection of acute and chronic myocardial ischemia. Importantly, our results show that postmortem imaging needs to be combined with CT-guided biopsies to achieve the highest performance.

CLINICAL RELEVANCE/APPLICATION

This study shows that minimally invasive autopsy (MIA) has high diagnostic performance to detect ischemic heart disease which is a very common cause of death in clinically deceased patients.

SSK04-03 Left Bundle Branch Block: Usefulness of MRI in the Evaluation of Regional Left Ventricular Dyssynchrony and in the Detection of Previous Myocardial Infarction with Late Enhancement

Wednesday, Nov. 29 10:50AM - 11:00AM Room: S504AB

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PURPOSE

Left bundle branch block (LBBB) is a common cardiac conduction abnormality diagnosed on ECG. LBBB can be a primary abnormality of the cardiac electrical conduction system or it can be secondary to other cardiogical pathologies such as myocardial infarction and cardiomyopathies. The presence of LBBB per se cannot be used as a single diagnostic criteria for the diagnosis of previous myocardial infarction. Aim of this study was to evaluate the mechanical left ventricular dyssynchrony with high temporal resolution cine MRI and to evaluate the presence of late-enhancement (LE) in order to diagnose previous myocardial infarction.

METHOD AND MATERIALS

38 patient with LBBB underwent cardiac MRI using a 1.5 T magnet (Magnetom Sonata, Siemens). The MRI protocol consisted of a left ventricular trueFISP functional study followed by Late Enhancement data sets acquired 10-15 minutes after iv administration of 0.2mmol/kg BW of extracellular Gd contrast agent. We used a segmented Inversion Recovery Turbo-FLASH sequence (TR:8ms;TE:4ms;TI:250-320ms;sl.thick:8mm). Different pattern of LE were related to the underlying pathology as stated by clinical and other diagnostic imaging features.

RESULTS

We detected a characteristic dyssynchronous ventricular contraction with septal flattening during early ventricular systole in all the patients, tenting of mitral valve apparatus in 5 pts and functional mitral regurgitation in 2 pts. In 1 pt we found the characteristic functional features of dilated cardiomyopathy with no myocardial area of LE. In 8 pts we found areas of LE (transmural in 3 pts and subendocardial in 5 pts) with typical patterns of myocardial infarction (MI). The location of MI was septal in 4 pts, infero-septal in 2 pts, lateral in 1pt, and superior in 1 pt. In 30 patients we found a reduction of the ejection fraction (75%).

CONCLUSION

Cardiac MRI is a useful diagnostic tool in the evaluation of LBBB when the assessment of ventricular dyssynerygy on echocardiography is not technically feasible and when the area of a previous myocardial infarction cannot be determined.

CLINICAL RELEVANCE/APPLICATION

MRI is a useful diagnostic tool in the evaluation of LBBB when US assessment of ventricular dyssynerygy isn't feasible and a previous possible myocardial infarction has to be determined.

SSK04-04 Utility of Native Myocardial T1 Mapping as a Diagnostic Tool for Ischemic and Non-Ischemic Cardiomyopathy

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S504AB

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PURPOSE

Native myocardial T1 mapping measures interstitial fibrosis and provides prognostic information in patients with cardiomyopathy. We sought to determine the diagnostic utility of native T1 mapping in identifying common cardiomyopathies - ischemic (CAD), dilated cardiomyopathy (DCM), and hypertrophic cardiomyopathy (HCM) - compared with the reference standard late gadolinium enhancement (LGE).

METHOD AND MATERIALS

We enrolled consecutive adult subjects referred for CMR evaluation of ischemic or non-ischemic cardiomyopathy. CMR was performed on a 1.5T magnet using standard cine, LGE, and native T1 mapping using a modified Look-Locker inversion recovery sequence. We compared the diagnostic accuracy of native T1 mapping versus LGE of the mid septum as well as all 16 segments of the left ventricle for etiology of cardiomyopathy.

RESULTS

We evaluated 1,950 myocardial segments in 130 subjects (mean age 48±11 years, 80% male; 90 CAD, 29 DCM, 11 HCM). Mid septal T1 values were similar in CAD vs. DCM and HCM (1051±51 msec, 1064±36, 1068±22 respectively, p=0.17). T1 values in segments with fibrosis on LGE were significantly lower than segments without fibrosis, regardless of etiology (1057±65 msec with fibrosis vs. 1042±52 without fibrosis, p<.0001). T1 values were markedly reduced in CAD in segments with lipomatous metaplasia (968±17 msec). However, the diagnostic accuracy of native T1 mapping in identifying the etiology of cardiomyopathy was poor. For a threshold T1 value of < 1024 msec in any segment, the AUC for identifying CAD vs. HCM or DCM was 0.565, sensitivity 39%, specificity 78%, PPV 86%, NPV 28%). There was no association between T1 values and standard imaging indices of disease severity (ejection fraction, total myocardial scar, myocardial mass).

CONCLUSION

Compared with LGE, native T1 mapping has limited diagnostic accuracy in distinguishing between etiologies of cardiomyopathy, likely due to considerable overlap of values in CAD, DCM, and HCM. There was no association between T1 values and severity of cardiomyopathy, as measured by ejection fraction, total myocardial scar (CAD), or myocardial mass (HCM).

CLINICAL RELEVANCE/APPLICATION

Native T1 mapping is a useful tool for tissue characterization. However, its utility to distinguish between ischemic, dilated, or hypertrophic cardiomyopathies is limited.

SSK04-05 References Values of Myocardial Strain Measurement Using Cardiovascular Magnetic Resonance Tissue Tracking for Both Ventricles in Asymptomatic Asian Cohort: Association with Cardiovascular Risk Factors

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S504AB

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PURPOSE

To provide the reference values of myocardial deformation parameters of both ventricles using cardiovascular MR with tissue tracking (CMR-TT) in asymptomatic Asian subjects and to evaluate the association of deformation parameters and Framingham risk score (FRS).

METHOD AND MATERIALS

We enrolled 120 asymptomatic healthy adults who underwent CMR, and all subjects demonstrated normal left ventricular systolic

We enrolled 129 asymptomatic healthy adults who underwent CMR, and all subjects demonstrated normal left ventricular systolic function. We assessed the FRS of all study population. Commercial software was used to derive myocardial deformation parameters of both ventricles from short-axis cine views and apical two-, three-, and four-chamber views. The reference value of each strain parameter was determined as mean value of every individual. The linear regression analysis was performed between all strain parameters and FRS. Iota coefficient for the inter-rater agreement of strain parameters was also calculated.

RESULTS

In total 129 patients, the reference values of left ventricle (LV) were 48.90 ± 9.05 for radial, -22.30 ± 2.33 for circumferential and -19.76 ± 2.22 for longitudinal global strain. The reference values of right ventricle (RV) were 18.63 ± 6.52 for radial, -10.60 ± 3.33 for circumferential and -25.06 ± 3.01 for longitudinal global strain. The median FRS was 7 (interquartile range 4-11). The LV strain parameters were significantly associated with FRS in univariate linear regression analysis: radial strain, beta = -0.155, p = 0.002; circumferential strain, beta = 0.56, p = 0.005; longitudinal strain, beta = 0.423, p = 0.043. However, RV strain parameters were not significantly associated with FRS: radial strain, p = 0.74; circumferential strain, p = 0.76; longitudinal strain, p = 0.09. The iota coefficient of all strain parameters were 0.915 for LV (p < 0.001) and 0.715 for RV (p < 0.001), respectively.

CONCLUSION

We present the reference values of strain parameters of both ventricles in asymptomatic Asian subjects. In contrast to RV parameters, LV strain parameters assessed by CMR-TT show significant association with FRS.

CLINICAL RELEVANCE/APPLICATION

We suggest reference values of myocardial strain parameters of both LV and RV assessed by CMR-TT in asymptomatic subjects and LV strain paramters show significant association with Framingham risk scores.

SSK04-06 Cardiac Magnetic Resonance Using Late Gadolinium Enhancement Imaging and T1 Mapping Predicts Poor Outcome in Patients with Atrial Fibrillation after Catheter Ablation Therapy

Wednesday, Nov. 29 11:20AM - 11:30AM Room: S504AB

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PURPOSE

Success rates for ablation therapy in patients with atrial fibrillation (AF) vary widely and patient selection criteria are poorly defined. We aimed to determine the pre-procedural value of cardiac magnetic resonance (CMR) and laboratory biomarkers of fibrosis for the prediction of poor response to ablation therapy.

METHOD AND MATERIALS

Left atrial (LA) late gadolinium enhancement (LGE) and LA T1 mapping were performed during pre-procedural CMR. Patients were categorized by four different fibrosis stages based on the percentage of LA wall enhancement on LGE-CMR (Utah stages I-IV). Plasma levels of relaxin and myeloperoxidase (MPO) and serum levels of MMP-mediated cardiac specific titin (TIM) and MMP-mediated collagen type IV (C4M) were obtained prior to ablation therapy. Poor outcome was defined by the reoccurrence of AF during 1-year follow-up (90 days blanking period). Univariate and multivariate cox proportional-hazards regression was used to identify significant predictors of AF recurrence.

RESULTS

A total of 61 patients were included in this prospective study (mean age: 60.3 + 12.5 years, 65.6% male). After 1-year follow-up AF reoccurred in 20 (32.8%) of all patients. Patients with a reoccurrence of AF showed a higher mean percentage of LA wall enhancement (26.7 ± 12.5 % vs. 17.0 ± 7.7 %; P<0.001), higher LA T1 relaxation times (857 ± 112 ms vs. 747 ± 91 ms; P<0.001), and higher plasma level of relaxin (0.7 ± 1.4 pg/ml vs. 0.4 ± 0.9 pg/ml; P=0.010). No significant differences were found in plasma concentrations of MPO and serum concentrations of TIM and C4M. In a multivariate analysis, poor ablation outcome was best predicted by advanced fibrosis stage (stage III and IV) (hazard ratio 5.487; P=0.001) and higher T1 relaxation times (hazard ratio 1.007; P=0.001). Plasma relaxin was not an independent predictor of poor outcome.

CONCLUSION

Pre-procedural CMR is a valuable tool for prediction of poor response to catheter ablation therapy in patients with AF. It offers various imaging techniques for outcome prediction and might be valuable for a better patient selection prior to ablation therapy.

CLINICAL RELEVANCE/APPLICATION

Pre-procedural CMR using LGE and T1 mapping might be useful for the prediction of poor response of patients with AF undergoing ablation therapy.

SSK04-07 Association between Abdominal Adiposity and Subclinical Measures of Left-Ventricular Remodeling and Diastolic Dysfunction in Diabetics, Prediabetics and Normal Controls without History of

Cardiovascular Disease as Measured by MR Imaging

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S504AB

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PURPOSE

Local, abdominal fat depots may be related to alterations in cardiac function and morphology due to a metabolic linkage, which could be further accelerated in diabetic patients. Therefore we aimed to determine their association with subtle cardiac changes and the potential interaction with hyperglycemic metabolic states.

METHOD AND MATERIALS

Subjects from the general population without history of cardiovascular disease (CVD) underwent 3 Tesla cardiac and body magnetic resonance imaging. Measures of abdominal adiposity such as hepatic proton-density fat fraction (PDFFhepatic), subcutaneous (SAT) and visceral abdominal fat (VAT) as well as established cardiac LV measures including LV remodeling index (LVCI) were derived. Associations and interactions were determined using linear regression analysis based on standard deviation normalized predictors.

RESULTS

Among 374 subjects (56.2±9.1 years, 58% males), 49 subjects had diabetes, 99 subjects had prediabetes and 226 represented normal controls. Only subtle cardiac alterations were observed (e.g. LVCI: 1.13±0.30). In multivariable analysis, VAT and PDFFhepatic were independent predictors of increased LVCI (ß=0.11 and 0.06, respectively), decreased LV end-diastolic volume (ß=-6.70 and 3.23, respectively), and LV stroke volume (ß=-3.91 and -2.20, respectively). In contrast, SAT was not associated. Hyperglycemic state or HbA1c-levels did not modify the associations between VAT or PDFF and LV measures (interaction term: all p>=0.29)

CONCLUSION

Particularly VAT, but also fatty liver are independently and incrementally associated with early LV remodeling and diastolic dysfunction in a general western population without history of CVD. Although a metabolic connection is suggestive, no interaction with the diabetic status was revealed for these important associations.

CLINICAL RELEVANCE/APPLICATION

Since LV remodeling and diastolic dysfunction is a precursor of heart failure and worse outcome, imaging-based quantification of VAT or fatty liver in patients without previous CVD could improve risk stratification and thus preventive medicine to avoid complications from heart failure in a very early state.

SSK04-08 Aortic Dimensions and Subclinical Atherosclerosis in Former National Football League Athletes

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S504AB

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PURPOSE

To evaluate whether past participation in the National Football League (NFL) is associated with increased prevalence of ascending aortic dilation and coronary artery calcium (CAC) on cardiac CT.

METHOD AND MATERIALS

This is a retrospective, cross-sectional study of 206 former National Football League (NFL) athletes compared with 759 matched male subjects from the XXX Heart Study (XHS) older than 40 years old with body mass index >= 20 kg/m2. Mid-ascending aortic dimensions were obtained from non-contrast, multidetector cardiac-gated CT scans performed as part of a screening protocol (NFL)

or as part of the XHS. CAC scores were obtained using the Agatston method. Multivariate logistic regression was performed to evaluate predictors of aortic size > 4.0 cm, CAC>0, and CAC>100 in each cohort.

RESULTS

Compared to the control group, former NFL athletes had significantly larger ascending aortic diameters (3.8±0.5 vs. 3.4±0.4 cm; p<0.0001). A significantly higher proportion of former NFL players had an aorta of >4.0 cm (29.6% versus 8.6%, p<0.0001). After adjusting for age, race, body surface area, systolic blood pressure, history of hypertension, current smoking, diabetes, and lipid profile the former NFL players still had significantly larger ascending aortas (p<0.0001). Former NFL players were twice as likely to have an aorta > 4.0 cm after adjusting for the same parameters. CAC scores were similar in both groups as was the distribution across CAC score categories (CAC=0, 1-100, and >100).

CONCLUSION

While CAC scores are similar between former NFL athletes and controls, ascending aortic dimensions are significantly larger in former NFL athletes even after accounting for their size, age and cardiac risk factors. Whether this translates to an increased risk is unknown and requires further evaluation.

CLINICAL RELEVANCE/APPLICATION

Past exposure to the hemodynamic effects of repetitive strenuous exercise among elite athletes may have lasting effects on aortic dimensions.

SSK04-09 Diagnostic Value of Cardiac Magnetic Resonance Imaging for Cardiac Mass in Children

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S504AB

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PURPOSE

The aim of this study is to evaluate the diagnostic value of cardiac magnetic resonance imaging(CMR) for cardiac mass in children.

METHOD AND MATERIALS

One hundred and eleven patients who were diagnosed cardiac mass by echocardiography were recommended to perform cardiac MRI from September 2006 to August 2016. Fifty patients (34 boys and 16 girls) who underwent both cardiac MRI, echocardiography and had histopathologic results or confirmed based on clinical diagnosis were enrolled in this study. Patient age ranged from 0.2 months to 183.2 months and the median age was 44.7 months (3.7y). All MRI examinations were performed on a 1.5 T clinical MRI system. A cine balanced steady-state free procession (b-SSFP) imaging, T1and T2 weighted imaging, first-pass perfusion (resting) imaging, post gadolinium T1W and late gadolinium-enhanced imaging were included in the scanning protocol. The characteristics of cardiac masses were reviewed, and the location of cardiac mass was identified. The comparison of diagnostic accuracy between echocardiography and cardiac MR using Chi-square was made.

RESULTS

Thirty-two cases(32/50) were confirmed by histopathologic results and in which twenty-three cases were correctly diagnosed by cardiac MRI, eighteen cases(18/50) were diagnosed based on clinical evidence and in which fourteen cases were correctly diagnosed by cardiac MRI. Benign tumors accounted for 86%(43/50) and malignant tumor accounted for 14%(7/50). Cardiac mass could be located in any part of heart (chamber, wall and epicardium) and most cardiac masses located in the ventricles and outflow tracts. Accurate rate of echocardiography for cardiac mass is 100% (but no characteristic diagnosis except myxoma). Accurate rate of echocardiography for mass characteristics is 6% (3/50) and accurate rate of CMR for mass characteristics is 74% (37/50). CMR provided significantly higher accuracy of pathologic diagnoses compared to echocardiography (p <0.0001).

CONCLUSION

CMR imaging is becoming a major imaging modality for assessment of cardiac mass in children and can provide the tissue characteristics and have higher accuracy for diagnosis of cardiac mass in children.

CLINICAL RELEVANCE/APPLICATION

Cardiac mass is rare in children. The imaging modalities for it mainly include echocardiography and CMR. CMR can provide accurate characteristics and is becoming a major modality for assessment.

SSK05

Science Session with Keynote: Chest (Diffuse Lung Disease)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S404CD

CH CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSK05-01 Chest Keynote Speaker: Current Challenges in ILD Analysis

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SSK05-02 Assessment of Interstitial Lung Disease Using Lung Ultrasound Surface Wave Elastography (LUSWE) and Validation with Quantitative CT and Pulmonary Function

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S404CD

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PURPOSE

Lung ultrasound surface wave elastography (LUSWE) may be useful for assessing interstitial lung disease (ILD) as LUSWE measures superficial lung tissue properties. We investigated surface wave speed in ILD and compared results to pulmonary function and quantitative parenchymal features.

METHOD AND MATERIALS

77 subjects with connective tissue disease and 19 healthy, never-smoking volunteers had PFTs within one year of LUSWE. All controls and 54 subjects had CT within 1 year of LUSWE. LUSWE measures are performed in seated upright at full inspiration. A 0.1s vibration at 100 Hz, 150 Hz, and 200 Hz is generated using a handheld indenter, and velocity is measured with an ultrasound probe at the same intercostal space. Bilateral upper lungs were measured anteriorly, mid-lungs laterally and lower lungs posteriorly. CALIPER (computer-aided lung informatics for pathology evaluation and rating) determined percent parenchymal interstitial abnormalities in a 15mm diameter hemisphere in CT regions studied by LUSWE. Categorical data were compared by chi square and continuous data by Wilcoxon Rank Sum.

RESULTS

The cases were significantly older ($p < 0.0001$) with a higher BMI ($p = 0.05$) and no difference in sex. Cases had lower FEV1 and FVC ($p < 0.0001$). Sonographic velocities were higher in all lung regions at all frequencies for cases, however the difference was greatest in the mid-lung at the 200Hz frequency. Median velocity in m/s was 5.84 vs 4.11 and 5.96 vs. 4.27 ($p<0.00001$) for case vs. control, left and right middle lung zones, respectively (see Table 1). LUSWE in the right mid-lung negatively correlated with FVC ($R = -0.23$, 95% CI -0.42 - -0.03) and also positively correlated with CALIPER percent ILA ($R = 0.35$, 95% CI 0.12 - 0.53). Nominal logistic regression was used in univariate analysis and found that mid-lung LUSWE at 200Hz was predictive of CT-ILD with an AUC of 0.94, $p < 0.0001$. A multivariate model including age was predictive with AUC of 0.96. For a model including right mid-lung LUSWE velocity at 200Hz, right lower %ILA, FVC and age to predict CT-ILD, the AUC approached 100.

CONCLUSION

LUSWE is a safe and noninvasive technique that may be useful for assessing the presence of ILD and correlates with function and quantitative CT.

CLINICAL RELEVANCE/APPLICATION

LUSWE could potentially be used as a screening tool to detect ILD in patients at risk without use of ionizing radiation or functional

testing.

SSK05-03 Reduced Lung Elasticity in Female Patients with Interstitial Lung Disease: Histogram Analysis and Comparison with Age, Sex-Matched Normal Controls

Wednesday, Nov. 29 10:50AM - 11:00AM Room: S404CD

Participants
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PURPOSE

To evaluate lung elasticity at the level of vital capacity in female patient with interstitial lung disease (ILD) using a histogram analysis by image registration of paired full inspiratory and expiratory CT scans.

METHOD AND MATERIALS

A total of 16 female patients with ILD and 8 age- and sex-matched normal controls who underwent paired CT scans at full inspiration and full expiration were included. Initially, the paired segmented CT images were aligned using surface-based affine registration. Second, landmark-based registration was sequentially performed using bronchial and pulmonary vascular landmarks (31 to 34 branching points of bronchus and peripheral pulmonary vessel for each lung) which were marked manually by one radiologist using in-house software. Then, lung attenuation-based deformable registration was applied. We obtained the x-, y-, z-axis and 3D distance of movement (mm) of each pixel for image registration between inspiration and expiration CT scans. Histogram analysis of those distances was performed in each axis. Nonparametric repeated-measures ANOVA was used for comparison and Spearman's correlation coefficient was used to assess relationships between the distance of movement and visual fibrosis score and pulmonary function test (PFT) results.

RESULTS

Mean distance error was 1.72 ± 1.32 mm in whole lung. Mean 3D distance of movement was significantly lower in the patient group (27.4 mm vs. 41.8 mm; p=.017), as well as percentile values of 3D distance of movement from 10th to 95th percentile (p<.05). Standard deviation (SD) and Entropy of 3D distance of movement were also significant lower in patient group (p=.017). When analyzed for each axis, mean, SD, entropy and 20th to 95th percentile of distance of movement were significantly lower in the patient group for y-axis (p<.05). The same trend was also observed for x- and z-axis, although not statistically significant. When compared with PFT results, forced vital capacity (FVC) showed significant positive correlation (R2=.271; p=.039) with mean 3D distance of movement.

CONCLUSION

Lung elasticity was significantly decreased in terms of absolute value and heterogeneity at the level of vital capacity in ILD patients.

CLINICAL RELEVANCE/APPLICATION

Decreased lung elasticity in ILD patients can be evaluated quantitatively by full inspiratory and expiratory CT scan, and it can be a potential biomarker of ILD with future investigation.

SSK05-04 HRCT Texture Feature Selection and Imaging Pattern Prediction of IPF using Quantum Particle Swarm Optimization

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S404CD

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PURPOSE

Idiopathic Pulmonary Fibrosis (IPF) is a fatal lung disease with a heterogeneous natural history. Some predictive clinical models have been developed but few incorporate High-resolution Computed Tomography (HRCT) information. We propose an algorithm leveraging HRCT imaging data to build a model that predicts IPF progression at an early stage.

METHOD AND MATERIALS

We collect anonymized longitudinal serial volumetric HRCT scans from patients with IPF. Radiologists visually contoured regions of interest (ROI) and annotated lung morphology types into progression or non-progression, at the previous visits before the changes occurred. Within ROIs at baseline, 71 imaging texture features were extracted from the grid sampled voxels. Quantum particle swarm optimization (QPSO) was used to select important features, coupled with a resampling technique and random forest. In QPSO algorithm, particles iteratively search the space and communicate within swarm so that important features can be found quickly. QPSO was inspired by quantum mechanics in physics and it exhibits superior searching capabilities by using an iterative probability density function. We utilize QPSO to search the feature space and build a random forest classifier based on the QPSO selected features.

RESULTS

The algorithm yields an interpretable model with 19 texture features and achieves 77.27% sensitivity, 85.15% specificity and 83.74% accuracy at ROI level on test set in predicting progression of 6 months to 1 year follow-ups. Compared to other state-of-the-art algorithms, our approach selects a smaller feature subset, has higher prediction accuracy and achieves more balanced classification.

CONCLUSION

We propose an integrated feature selection and pattern recognition algorithm powered by QPSO that achieves superior prediction performance. The algorithm is widely extensible and has great potentials on offering IPF patients timely treatments as HRCT is inherent to the diagnosis of IPF.

CLINICAL RELEVANCE/APPLICATION

Idiopathic pulmonary fibrosis exhibits a heterogeneous natural history. We build a predictive model to anticipate disease courses and help clinicians make timely decisions.

SSK05-05 Evaluating Treatment Response in Patients with Systemic Sclerosis and Diffuse Interstitial Lung Involvement: Quantitative CT as a New Outcome Measure

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S404CD

Participants
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PURPOSE

To compare semi-quantitative analysis (semi-QA) and quantitative analysis (QA) in the evaluation of treatment response in patients with interstitial lung involvement in systemic sclerosis (SS).

METHOD AND MATERIALS

31 patients with interstitial lung involvement in SS underwent functional evaluation,echocardiography and chest CT scan before and after treatment with rituximab and common anti-inflammatory drugs.Two chest radiologists evaluated the CT scans in consensus for a semi-QA by applying the international Goh score at 5 lung levels.QA was performed by CALIPER,a lung texture analysis program quantifying the relative volume of Normal, Ground-glass(GG), Reticular, and Honeycombing patterns in the whole lungs.Data obtained from semi-QA and QA were compared and correlated with clinical data (Pearson correlation, intraclass correlation coefficient, t-test). Analysis of ROC curves was performed to assess the predictability of a decline in FVC>10% or DLco>15%, commonly used to define lung disease progression.

RESULTS

Most patients (23/31,74.2%) had diffuse disease.By analyzing all 62 CT scans semi-QA and QA had a good reproducibility (ICC:0.67) for GG and only weak (ICC:0.27) for Reticular.Correlations between FVC,TLC,RV,DLco,Kco and semi-QA scores were lower (r=0.3 to 0.4) than QA scores, all statistically significant with the strongest correlations for GG or GG+Reticular and FVC (both r=-0.71).A main pulmonary artery >29mm distinguished patients with higher QA scores in GG, Reticular, GG+Reticular (p<.001),while echographic PASP did not. ΔFVC had a weak correlation with ΔDLco(r=0.4).Semi-QA scores and QA scores were not accurate in predicting a decline in FVC>10%, DLco>15%,or both combined (AUC: 0.33 to 0.70,p>0.05).

CONCLUSION

ΔFVC and ΔDLco reflect different aspects of disease progression, including impairment of volumes and diffusing capacity. QA allows an objective and reproducible evaluation of both aspects contemporary, quantifying changes in lung patterns during treatment follow-up and correlating with lung function and pulmonary hypertension better than semi-QA. QA is a promising imaging biomarker in evaluating treatment response in patients with SS to add to ΔFVC and ΔDLco, likewise recently recommended in IPF.

CLINICAL RELEVANCE/APPLICATION

QA can help multidisciplinary teams in daily practice in evaluating treatment response in SS patients with interstitial involvement.QA with its reproducibility is a promising outcome measure for RCT.

SSK05-06 Diagnostic Significance of Fibrotic CT Patterns Not Addressed in Current Guidelines

Wednesday, Nov. 29 11:20AM - 11:30AM Room: S404CD

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PURPOSE

A small but substantial proportion of CT scans in patients with pulmonary fibrosis cannot be classified using current guidelines. The purpose of this study was to assess the diagnostic significance of these "indeterminate" cases on CT relative to pathologic findings.

METHOD AND MATERIALS

Subjects with a multidisciplinary diagnosis of IPF, interstitial pneumonia with autoimmune features (IPAF), and hypersensitivity pneumonitis (HP); pathological data from open lung biopsy; and chest CT within one year of biopsy were included in the study. Chest CT scans were analyzed by 2 chest radiologists. Cases were classified as interstitial pneumonia (UIP), possible UIP, or inconsistent with UIP on chest CT as per guidelines. Cases which could not be confidently categorized using strict adherence to current guidelines were additionally annotated as "indeterminate" for subset analysis. Lung biopsies were read by a pathologist with expertise in the diagnosis of interstitial lung diseases.

RESULTS

CT UIP patterns were as follows: UIP (102, 39.4%), possible UIP (54, 21.0%), and inconsistent with UIP (103, 25.4%); 19 (11.9%) CT scans scored as possible UIP were also annotated as "indeterminate," mostly due to diffuse distribution in the axial and/or zonal planes. UIP, possible UIP, and inconsistent with UIP CT patterns were associated with pathological UIP in 90.2%, 81.5%, and 52.4% of subjects; respectively. Those with an "indeterminate" CT pattern showed UIP on pathology in 68.4% of cases, which was not statically different compared to the inconsistent with UIP group on CT ($p=0.198$) but was different from the CT UIP group ($p=0.010$). After exclusion of these cases, the high confidence possible UIP subset showed a UIP pattern on pathology in 88.6% of subjects, which was not statistically different compared to the UIP CT group ($p=0.784$) but did differ from the inconsistent with UIP group ($p<0.001$). The difference between pathology in the "indeterminate" and high confidence possible UIP CT patterns approached statistical significance ($p=0.069$).

CONCLUSION

There are a substantial number of cases which cannot be confidently categorized using current CT guidelines in IPF. These cases are often classified as possible UIP but differ from the high confidence cases of possible UIP in regard to their pathological UIP diagnosis.

CLINICAL RELEVANCE/APPLICATION

Our data suggests that a 4th UIP CT category may be necessary for optimal diagnosis in suspected IPF.

SSK05-07 Lung Density Analysis Using Quantitative Chest CT for Early Diagnosis of Chronic Lung Allograft Dysfunction (CLAD)

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S404CD

Awards
Student Travel Stipend Award

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PURPOSE

CLAD and its sub-types, bronchiolitis obliterans syndrome (BOS) and restrictive allograft syndrome (RAS) limit long-term survival following lung transplantation (LTx). Early diagnosis may allow earlier intervention to improve ultimate prognosis. The purpose of this study was to investigate the utility of quantitative CT lung density analysis in early diagnosis of CLAD.

METHOD AND MATERIALS

A retrospective study was conducted of 82 patients having routine periodic surveillance with pulmonary function tests (PFT) and low dose CT (120kV, 25mAs) following LTx. CLAD was defined as FEV1 <80% of baseline. BOS was defined as CLAD with TLC >=90% and RAS was defined as CLAD with TLC <90%. For the CT analyses, following definitions were applied: pre-onset CT when FEV1 <=90% (pre-CLAD). Control (No-CLAD) CT was defined when FEV >90% without Tx lung complications on the latest CT. CT scans were evaluated for 30 single LTx (15 CLAD: 3 RAS and 12 BOS, 15 Control) and 52 bilateral LTx (29 CLAD:12 RAS and 17 BOS, 23 Control). The contributions of low and high-density from each lung were determined from a CT histogram. Nonparametric indices were calculated; including the right tail weight (rqw) and the left tail weight (lqw) of the CT density distribution as well as the ratio: log (rqw0.875/lqw0.125). The area under the Receiver Operating Characteristic curve (AUC) and the Mann-Whitney test were used to evaluate the significance of difference in the metric; log (rqw0.875/lqw0.125) between CLAD and No-CLAD patients before CLAD onset.

RESULTS

Comparison of single LTx: CLAD and No-CLAD, the AUC was 0.80 [95% CI: 0.62- 0.93] (Figure 1a). Bilateral LTx: RAS and No-CLAD, the AUC was 0.80 [95% CI: 0.63-0.91] (Figure 1b), and BOS and No-CLAD, the AUC was 0.78 [95% CI: 0.62-0.89] (Figure 1c). There was a statistical significance between CLAD, RAS, BOS vs No-CLAD ($P < 0.05$) for both single and bilateral LTx patients.

There was no statistical significance between single and bilateral No-CLAD, tail ratio (P=0.42).

CONCLUSION

Quantitative CT parameters derived from a lung density histogram may help early diagnosis of CLAD in patients with single and bilateral lung transplantation.

CLINICAL RELEVANCE/APPLICATION

A quantitative density metric for CLAD patients might improve early detection of CLAD. It can allow earlier intervention to influence patient management and help to improve clinical outcomes.

SSK05-08 Non-Contrast Computed Tomography in Asthmatics Shows That Sarcopenia Correlates Measured In the Paraspinous Muscle on Non-Contrast CT Is Inversely Correlated With IL-6 and Asthma Exacerbations: Results from the Severe Asthma Research Program

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S404CD

Participants
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PURPOSE

We sought to determine if a novel imaging biomarker for sarcopenia, found on non contrast CT of the paraspinous musculature, had any relationship to interluekin-6 (IL-6) and asthma exacerbation.

METHOD AND MATERIALS

:This was an IRB approved and HIPAA compliant study involving 173 patients enrolled in the Severe Asthma Research Program. There were 21 normal volunteers, 72 non-severe asthmatics, and 79 severe asthmatics (age range 2 - 72 years). Each patient's diastolic blood pressure, BMI, total cholesterol, triglyceride levels, HDL, LDL, fasting glucose, IL-6 plasma levels, asthma exacerbation frequency and steroid dosage per day were recorded. Region-of-interest Hounsfield unit (HU) measurements were obtained in liver density (LD), trabecular density at vertebrae levels T12 and L1, and paraspinal muscle density. Kruskal-Wallis and Fisher's exact test were used ($P<0.05$) to compare groups for continuous and discrete variables, respectively.

RESULTS

. For males and females combined (and individually), patients with MetS had lower liver density than those without MetS. Severe and non-severe asthmatics had lower liver HU (p-value = 0.0097), lower trabecular HU (p-value = 0.0006), and lower paraspinal muscle HU (p-value = 0.00002) when compared with normal volunteers. Females had stronger correlations between MetS, asthma severity, and liver density than males. Steroid dosage per day did not correlate with liver density or MetS. A lower LD, lower T12 and L1 BMD, and lower PSMD was found in severe asthmatics. IL6 was strongly correlated with PSMD (Spearman r= -0.62, p< 0.0001) and moderately correlated with hepatic density (Spearman r = -0.35, p < 0.03) Ashtma exacerbations trended to be more common with progressive sarcopenia.

CONCLUSION

IL=6 is strongly correlated with PSMD. The presence of MetS was inversely related to vertebral body BMD and PSMD.. The use of inhaled or oral steroids was not found to be associated with MetS or LD, as there may not be a detectable dose-effect.

CLINICAL RELEVANCE/APPLICATION

A simple imaging biomarker for sarcopenia is now available from routine non contrast CT chest exams that is negatively correlated with IL-6. This is confirmatory evidence that the progressive deposition of intramuscular fat is detrimental to normal health and promotes an underlying increase in inflammatory cytokines.

SSK05-09 Low-dose CT Using Model Based Iterative Reconstruction at Chest Radiography Dose Levels: A Pilot Study in Patients with Cystic Fibrosis Undergoing Treatment with Ivacaftor (Kalydeco)

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S404CD

Participants
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PURPOSE

The purpose of this prospective feasibility study was to assess the utility of a modified low-dose CT thorax protocol reconstructed with Model Based iterative reconstruction (MBIR) for the surveillance of pulmonary disease in patients with cystic fibrosis (CF).

METHOD AND MATERIALS

Following institutional review board approval, 15 patients with CF underwent routine quarterly radiological follow-up with low-dose CT thorax for 12 months with a final low-dose CT thorax at 24 months following initiation of Ivacaftor therapy. A modified 7-section, low-dose axial CT protocol reconstructed with adaptive statistical iterative reconstruction (IR) (LD-ASIR) was used for the first 12-month quarterly studies. A modified low-dose volumetric protocol reconstructed with model-based IR (LD-MBIR) was used at 24 months. The image quality of both techniques was assessed quantitatively and qualitatively by 2 experienced readers who also quantified disease severity using a validated scoring system (Bhalla score).

RESULTS

15 patients (7 female, 8 male) with a mean age of 26.5±6.1 years of age were included in the study. No significant change was observed in mean Bhalla score over the study period (p=0.51). Body mass index and pulmonary function measures increased significantly after 1 and 2-years of treatment. LD-MBIR studies were performed at a significantly lower mean effective dose (0.09±0.01mSv) than LD-ASIR studies (0.10±0.02mSv)(p=0.02). Quantitative measures of image noise and signal-to-noise ratios did not differ significantly between each low-dose protocol. Subjective image assessment of mediastinal structures was significantly worse with the LD-MBIR studies compared to the modified LD-ASIR studies however diagnostic acceptability of lung assessment was similar in both imaging techniques.

CONCLUSION

The use of MBIR with a volumetric low-dose protocol enabled the acquisition of diagnostic quality lung CT images at a dose equivalent to that of a PA and lateral chest radiograph with the added advantage of full volumetric imaging of the entire lungs

CLINICAL RELEVANCE/APPLICATION

This LD MBIR technique provides full volumetric imaging of the lungs and allows earlier and more reliable detection of bronchiectasis, mucus plugging and other subtle findings than with chest radiography at similar radiation doses and is ideally suited for follow-up of younger patients with chronic lung conditions

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SSK06

Science Session with Keynote: Gastrointestinal (Advanced Liver MRI Techniques)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: E350

GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSK06-01 Gastrointestinal Keynote Speaker: Advances in Liver MRI Techniques

Participants
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SSK06-02 Compressed-Sensing Accelerated Isotropic 3D MRCP: Feasibility Study in Patients with Pancreatobiliary Disorders

Wednesday, Nov. 29 10:40AM - 10:50AM Room: E350

Participants
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PURPOSE

to prospectively compare image quality of compressed-sensing (CS) accelerated 3D MR cholangiopancreatography (MRCP) to conventional navigator-triggered (NT) 3D MRCP, in patients with pancreatobiliary disorders.

METHOD AND MATERIALS

Sixty-two patients (38 men and 24 women, median age, 56 years, range, 24-84 years) underwent 3D MRCP at 3T. Three protocols were performed in each patient: a CS-accelerated breath-hold (BH) protocol based on a prototype sequence; a CS-accelerated NT protocol based on a prototype sequence, and a conventional NT protocol. Acquisition time of each protocol was recorded. Image quality of predefined segments of the pancreatobiliary tree was rated on a 5-point scale by two radiologists independently, who were blinded to the acquisition protocols.

RESULTS

Acquisition time for the CS-BH protocol was 17 seconds, for CS-NT was 134.1±33.5 seconds, both significantly shorter than the conventional NT protocol (364.7±78.4 seconds, both $p<0.01$). Severe respiratory motion artifacts was significantly reduced with the CS- BH protocol (4.8%, compared to 11.3% and 16.1% for CS-NT and conventional NT protocol, respectively), while overall image quality of the biliary tree was higher($p<0.05$, compared to both NT protocols). However, CS-BH was less efficient in depicting pancreatic ducts. Overall image quality of the pancreatic duct was better with the CS-NT protocol ($p<0.05$, compared to CS-BH and conventional NT protocols). Acceptable or better image quality (score>=3) of the entire pancreatic duct (head, body and tail) was achieved in 90.9% patients with CS-NT, 78.2% with CS-BH, and in 83.6% with conventional NT protocol.Acceptable or better image quality for the entire pancreatobiliary tree was achieved with in 95.2% patients with CS-BH +CS-NT protocol, compared to 82.3% with the conventional NT protocol.

CONCLUSION

CS-accelerated 3D MRCP is feasible in routine patients. The protocol is time-efficient and overall image quality is superior than the conventional approach.

CLINICAL RELEVANCE/APPLICATION

CS-accelerated BH and NT 3D MRCP are both feasible in clinical routine. CS-BH-MRCP is free from respiratory movement artifacts and has better image quality for the biliary tree. CS-NT-MRCP can be used to assess pancreatic ducts, when they are not

adequately depicted with CS-BH. The combined CS-BH and CS-NT protocol achieves high success rate for imaging the entire pancreaticobiliary tree, while the acquisition time is still reduced.

SSK06-03 Evaluation of HCC Response to Locoregional Therapy: Validation of MRI-Based Response Criteria Against Explant Pathology

Wednesday, Nov. 29 10:50AM - 11:00AM Room: E350

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PURPOSE

To evaluate the performance of various magnetic resonance imaging (MRI) response criteria for the prediction of complete pathologic necrosis (CPN) of hepatocellular carcinoma (HCC) post locoregional therapy (LRT) using explant pathology as reference.

METHOD AND MATERIALS

We included 61 patients (M/F 46/15, mean age 60y) who underwent liver transplantation after LRT with transarterial chemoembolization plus radiofrequency or microwave ablation (n=56), or 90Yttrium radioembolization (n=5). MRI was performed within 90 days of liver transplantation. Three independent readers assessed the following criteria: RECIST, EASL, mRECIST, percentage of necrosis on subtraction images, and diffusion-weighted imaging (DWI) [qualitative (signal intensity) and quantitative (apparent diffusion coefficient, ADC)]. Degree of necrosis was retrospectively assessed at histopathology. Intraclass correlation coefficient (ICC) and Cohen's kappa were used to assess inter-reader agreement. Logistic regression and ROC analyses were used to determine imaging predictors of CPN. Pearson correlation was performed between imaging criteria and pathologic degree of tumor necrosis.

RESULTS

97 HCCs (mean size 2.3±1.3 cm) including 28 with CPN were evaluated. There was excellent inter-reader agreement (ICC 0.77-0.86, all methods). EASL, mRECIST, percentage of necrosis and qualitative DWI were all significant ($p<0.001$) predictors of CPN, while RECIST and ADC were not. EASL, mRECIST and percentage of necrosis performed similarly (AUCs 0.810-0.815) while the performance of qualitative DWI was lower (AUC 0.622). Image subtraction demonstrated the strongest correlation ($r=0.71-0.72$, $p<0.0001$) with pathologic degree of tumor necrosis.

CONCLUSION

EASL/mRECIST criteria and image subtraction have excellent diagnostic performance for predicting CPN in HCC treated with LRT, with image subtraction correlating best with pathologic degree of tumor necrosis. Thus, MR image subtraction is recommended for assessing HCC response to LRT.

CLINICAL RELEVANCE/APPLICATION

Image subtraction is recommended for assessing HCC response to LRT when performing MRI. RECIST and ADC should not be used for prediction of CPN.

SSK06-04 Clinical Feasibility of Implementing DCE-MRI in Routine Liver MRI Using Golden-Angle Radial Sparse Parallel MRI: Preliminary Results

Wednesday, Nov. 29 11:00AM - 11:10AM Room: E350

Participants
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Hersh Chandarana, MD, New York, NY (*Abstract Co-Author*) Equipment support, Siemens AG; Software support, Siemens AG; Advisory Board, Siemens AG;

PURPOSE

To investigate clinical feasibility of implementing dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) in routine liver MRI using Golden-angle Radial Sparse Parallel (GRASP) MRI.

METHOD AND MATERIALS

In this IRB-approved ongoing prospective study, 25 patients who were scheduled for liver biopsy or resection have been enrolled and informed consent was obtained from all patients. Liver MRI was performed using incoherent undersampling technique at 3T. A standard dose of extracellular contrast media was injected, and T1-weighted images (T1WI) were obtained using incoherent undersampling technique in free-breathing. Images were reconstructed to achieve either 13.3- or 3.3-second time resolution. On 13.3-second time resolution T1WI with respiratory gating, motion and overall image quality were assessed on four-point scale by two radiologists in consensus, and 3.3-second time resolution T1WI was analyzed using software of dual-input single compartment

model.

RESULTS

In 25 patients, motion artifact was 1.5±0.5, 2.1±0.3, 1.0±0.3 and 1.0±0.0 on pre, arterial, portal venous and delayed phase which indicated no significant motion artifact. Overall image quality was 3.9±0.6, 3.5±0.5, 3.9±0.3, and 3.8±0.4, respectively. In all patients, perfusion analysis was done successfully. After excluding one patient who was treated with chemoembolization, patients with advanced fibrosis (n=7, >=F2) showed substantially high arterial fraction (67.0±17.1%) than patients with no or early fibrosis (n=18, F0-1) who had arterial fraction of 44.7±27.6% (P<0.05).

CONCLUSION

GRASP technique allowed implementation of DCE in routine liver MRI by obtaining high time-resolution and sufficient spatial resolution.

CLINICAL RELEVANCE/APPLICATION

Implementation of DCE-MRI in routine MRI would facilitate its application for various organs and contribute to non-invasive diagnosis and monitoring by displaying hemodynamic information of lesions.

SSK06-05 An Experimental Study on the Assessment of Renal Fibrosis by Using Magnetic Resonance T1rho Imaging

Wednesday, Nov. 29 11:10AM - 11:20AM Room: E350

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PURPOSE

To correlate magnetic resonance (MR) T1 relaxation time in the rotating frame (T1rho or T1ρ) with degree of renal fibrosis in a rat model of unilateral ureteral obstruction (UUO).

METHOD AND MATERIALS

This study was approved by the institutional animal care and use committee. UUO was created in each of 36 rats. UUO-A group with 6 rats, longitudinal T1rho value was performed before the UUO (day 0) and on days 1, 3, 5, 10, and 15 after the UUO and was followed by histopathologic analysis (one rat died on 11 days after the UUO). Six rats from UUO-B group (n = 30) were examined at each of five time points on days 0, 1, 3, 5 and 10 after the UUO. Four rats from Sham group (n = 12) were examined on days 1, 5, and 15 after UUO. Hematoxylin-eosin, Masson trichrome staining and a-smooth muscle actin (a-SMA) were performed. T1rho Sequences with Stretched adiabatic as Spin lock pulse type. Spin lock time: 1, 27, 54 ms,with 3.0T clinical MR scanner.

RESULTS

Histopathologic examination revealed typical renal fibrosis on the side with UUO. The T1rho values increased over time on the UUO side, Mean T1rho value with day 0, 1, 3, 5, 10, and 15 after the UUO were 142.23±8.69, 149.53 ±9.38, 172.53 ±13.53, 181.05 ±17.34, 216.31 ±22.64, 228.47 ±26.95ms, respectively. Sham rats were 140.28 ±7.19, 137.74 ±9.38, 138.89 ±17.76 ms, respectively. Mean T1rho value associated positively ($r = 0.868$ $P < 0.001$) with a-SMA expression level.

CONCLUSION

Our study shows that the degree of renal fibrosis was correlated with degree of increase with T1rho value in model induced by UUO.

CLINICAL RELEVANCE/APPLICATION

MR-T1rho may become a noninvasive imaging tool for the diagnosis of renal fibrosis.

SSK06-06 Histologic Characteristics of Hepatocellular Carcinoma with Irregular Rim-Like Arterial Phase Enhancement

Wednesday, Nov. 29 11:20AM - 11:30AM Room: E350

Participants
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PURPOSE

To examine the histopathologic characteristics of hepatocellular carcinoma (HCC) with irregular rim-like arterial phase enhancement, which has been reported to be associated with more aggressive tumor behavior.

METHOD AND MATERIALS

Institutional review board approved this retrospective study and waived the informed consent. Our subjects were 84 pathologically

confirmed HCCs in 84 patients who underwent curative hepatic resection after gadoxetate-enhanced magnetic resonance (MR) imaging between January 2008 and February 2013. Two abdominal radiologists independently reviewed the MR images and classified HCCs into two categories: HCC showing irregular rim-like arterial enhancement (IRE-HCC) or HCC showing hypovascularity or diffuse arterial enhancement (non-IRE-HCC). We assessed and compared their clinical and pathologic characteristics, using a representative whole-section slide of each case. Differences in disease-free survival were analyzed using the Kaplan-Meier method with the log-rank test. The chi-square, Fisher exact test, or Mann-Whitney test was used to compare the variables.

RESULTS

Of the 84 HCCs, 22 and 51 were classified as IRE-HCCs and non-IRE-HCCs by both reviewers, respectively. Classification was discordant in the remaining 11 patients. IRE-HCC showed, compared to non-IRE-HCC, poorer five-year disease-free survival after curative resection (33.6% vs. 60.3%; P = .030), more frequent microvascular invasion (91% vs. 35%). IRE-HCCs were also associated with lower microvascular density (227 vs. 437 per mm2), more frequent sinusoidal microvascular pattern (55% vs. 0%), larger necrotic area (15% vs. 0%), and larger stromal area (8.3% vs. 2.2%), suggesting more hypoxic and fibrotic microenvironment, and exhibited higher expression of immunomarkers of hypoxia (CAIX, 64% vs. 8%) and stemness (K19 protein, 27% vs. 6%). P-values were < .001 for all comparisons except for K19 (P = .018). Discordant tumors showed intermediate features between IRE-HCC and non-IRE-HCC.

CONCLUSION

Irregular rim-like arterial enhancement of HCC is associated with hypoxic and fibrotic tumor microenvironment which are related with hypoxia and stemness marker expression and poor prognosis.

CLINICAL RELEVANCE/APPLICATION

IRE-HCCs may be associated with worse clinical outcome and histopathologic features related to aggressive biologic behavior, compared to non-IRE-HCCs.

SSK06-07 Impacts of Adding Recent CT Arterial Phase Images On Diagnostic Performances of Gadoxetic Acid-Enhanced MRI in Assessment of HCC

Wednesday, Nov. 29 11:30AM - 11:40AM Room: E350

Participants
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PURPOSE

To investigate impacts of adding recent CT arterial phase findings on diagnostic performances of gadoxetic acid-enhanced MRI in the assessment of hepatocellular carcinoma (HCC)

METHOD AND MATERIALS

We retrospectively identified 1272 patients (1026 men, 246 women; mean age, 56.6 years) with pathologically confirmed 1490 nodules (1370 HCCs, 60 dysplastic nodules, 39 combined HCC and cholangiocarcinomas, 13 cholangiocarcinomas, 8 nodules with other pathologies) between January 2008 and December 2016 with the following inclusion criteria: patients with chronic hepatitis or liver cirrhosis who had pathologically confirmed focal hepatic lesions; who underwent both multiphase CT and gadoxetic acid-enhanced MR I within 120 days before the pathologic exams; and the size of lesions <= 3 cm. We compared the enhancement patterns on arterial phase imaging between the two imaging modalities. The sensitivity and 95% confidence interval (C.I.) for detecting arterial hyperenhancement in patients with HCCs on a per-nodule basis was compared between the MRI only analyses and the CT+MRI analyses using generalized estimated equations based on a binary logistic regression model to account for data clustering and dependency, as some patients had more than one nodules.

RESULTS

The mean time interval between MRI and CT was 16.5 days. Among the 1490 nodules, 1361 nodules (91.3 %) had the same arterial enhancement patterns both on CT and MRI. In the remaining 129 nodules (105 HCCs and seven non-HCC lesions) with the different enhancement patterns between CT and MRI, arterial hyperenhancement was detected only by CT in the majority of cases (86.8%, 112/129). The sensitivity in detecting arterial hyperenhancement in HCC was significantly improved in the CT+MRI analyses (92.4 %; 95% C.I., 90.9 to 93.7) compared to the MRI only analyses (84.7 %; 95% C.I., 82.2 to 87.0) (P<0.001).

CONCLUSION

Adding recent CT arterial phase findings can improve the detection of arterial hyperenhancement of gadoxetic acid-enhanced MRI in the evaluation of HCC.

CLINICAL RELEVANCE/APPLICATION

Arterial phase findings on recent CT images can serve a substitute for suboptimal arterial phase MR images on gadoxetic acid-enhanced MRI in the assessment of HCC.

SSK06-08 A Prospective and Long-Term Follow-Up Study of Non-Hypervascular Hypointense Nodules on the Hepatobiliary Phase of Gadoxetic Acid-Enhanced MRI

Wednesday, Nov. 29 11:40AM - 11:50AM Room: E350

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PURPOSE

To investigate the incidence of non-hypervascular hypointense nodules on the hepatobiliary phase (HBP) of gadoxetic acid-enhanced MRI and to identify the incidence of arterial hypervascular transformation and associated features in a prospective cohort with a long-term follow-up

METHOD AND MATERIALS

A prospective surveillance study included 407 cirrhosis patients at high risk for HCC who underwent one to three, biannual screening examinations with gadoxetic acid-enhanced MRI between November 2011 and August 2014. Among them, 40 patients were identified to have 63 hypovascular hypointense nodules on HBP of gadoxetic acid-enhanced MRI. Follow-up contrast-enhanced MRI and CT were reviewed to identify hypervascular transformation (median follow-up period, 45 months). Univariate and multivariable Cox proportional hazards model with robust standard errors for clustered data were used to investigate the association between arterial hypervascular transformation and clinical and imaging features with respect to nodule size, signal intensity on T1-, T2-, diffusion-weighted, portal and delayed phase images, and intratumoral fat.

RESULTS

The incidence of non-hypervascular hypointense nodules on HBP in the prospective cohort was 9.8 % (40/407). On follow-up images, the 1-, 3-, and 5-year cumulative incidences of hypervascular transformation were 6.4, 12.8, and 24.3 %, respectively. Univariate analyses revealed the size >= 1cm and hyperintensity on T1-weighted images as significant risk factors for hypervascular transformation. According to the multivariable analysis, the size >= 1cm was independently associated with hypervascularization with a hazard ratio HR of 12.6 (P=.02). The 5 year-cumulative incidence of nodules >= 1cm in size (52.5%) was more than 10 folds compared to that of nodules smaller thant 1cm (4.4%).

CONCLUSION

Our study demonstrates the incidence of non-hypervascular hypointense nodules on HBP and hypervascular transformation in a prospective cohort. Non-hypervascular hypointense nodules >= 1cm in size are strongly associated with hypervascular transformation.

CLINICAL RELEVANCE/APPLICATION

Non-hypervascular hypointense nodules on HBP >= 1cm in size should be cautiously followed up with their culmulative incidence of hypervascular transformation in mind.

SSK06-09 High-Precision Computed Diffusion Weighted Images for the Diagnosis of Hepatocellular Carcinoma

Wednesday, Nov. 29 11:50AM - 12:00PM Room: E350

Participants
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PURPOSE

Diffusion-weighted images (DWI) obtained with higher b-values yield better contrast between tumor and background normal tissue. Computed DWI (c-DWI) can calculate high b-value images from DWI obtained at lower b-values. However, the image quality of c-DWI may be degraded due to mis-registration between image acquisitions with different b-values. We developed high-precision c-DWI (hc-DWI) in which mis-registration was reduced by applying non-rigid registration technique to real DWI (r-DWI) with different b values. We tested our hypothesis that hc-DWI can improve image quality in diagnosing hepatocellular carcinoma (HCC) compared to conventional c-DWI (cc-DWI).

METHOD AND MATERIALS

In 75 patients with HCCs we acquired r-DWIs with b-value at 150, 600, and 1000 s/mm2. We defined the r-DWI acquired with b = 1000 s/mm2 as standard. C-DWIs with b-value at 1500 s/mm2 were calculated with DWIs at b-values of 150 and 600 s/mm2. For generating hc-DWI we used a non-rigid image registration for avoiding mis-registration of two different b-value images and an image filter to remove abnormal values from the apparent diffusion coefficient map.Two radiologists evaluated the image quality of each DWI by consensus reading using a 3-point scale where 1 = poor (non-diagnostic), 2 = fair (diagnostic but blurred margin), 3 = good (good quality and sharp margin). They also evaluated the signal intensity of HCC using a 3-point score where 1 = not visible, 2 = discernible, and 3 = clearly visible and calculated the contrast ratio (CR) between HCC and the surrounding liver parenchyma.

RESULTS

Image quality was better with hc-DWI compared to cc-DWI ($p < 0.01$). The visual score of HCC was also better with hc-DWI compared to cc-DWI ($p < 0.01$). In addition, the CR for HCC was significantly higher in hc-DWI compared to cc-DWI (mean value: 2.6 and 2.1 for hc-DWI and cc-DWI, $p < 0.01$).

CONCLUSION

Image quality, subjective visual score, and CR of HCC was higher in hc-DWI compared to cc-DWI.

CLINICAL RELEVANCE/APPLICATION

Hc-DWI may be useful for characterization of HCC compared to cc-DWI.

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SSK07

Science Session with Keynote: Gastrointestinal (Quantitative Imaging and Machine Learning)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: E353A

BQ GI IN MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Srinivasa R. Prasad, MD, Houston, TX (*Moderator*) Nothing to Disclose
Aya Kamaya, MD, Stanford, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSK07-01 Gastrointestinal Keynote Speaker: Is There a Role of Machine Learning in Oncology?

Participants
Garry Choy, MD, MS, Boston, MA (*Presenter*) Nothing to Disclose

SSK07-02 Machine Learning-Based Radiogenomics in Metastatic Colon Cancer: Association between Quantitative Tumor MRI Radiomic Features and KRAS Mutation Status

Wednesday, Nov. 29 10:40AM - 10:50AM Room: E353A

Participants
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PURPOSE

Assessment of KRAS mutation status is essential for prognosis assessment and for guiding treatment decisions in patients with metastatic colon cancer. This study investigates the association between quantitative tumor MRI features and KRAS mutation status in this patient population.

METHOD AND MATERIALS

In this IRB-approved retrospective study, we identified 52 patients with stage 4 colon cancer with hepatic metastases reported on abdominal MRI studies performed from 2007-2013. KRAS mutation status was ascertained from the medical record. The largest hepatic lesion was identified on the portal venous phase T1-weighted fat-suppressed post-contrast images and manually segmented. MR radiomic feature vectors were extracted from each lesion using quantitative morphological and texture analysis. Univariate logistic regression analysis was used to assess for independent contribution of 18 extracted morphological features and 32 extracted texture features to mutation status prediction. A linear support vector machine (SVM) machine learning technique was applied to the extracted imaging phenotype vector to predict tumor mutation status. The classifier was trained and tested using 10-fold cross validation to avoid overfitting. ROC analysis and the area under the curve (AUC) were used to assess classification performance.

RESULTS

60% (19/31) of patients had tumors with KRAS mutations. Tumor circularity and tumor coarseness exhibited significant differences in mean values between KRAS-wildtype and KRAS-mutated tumors ($p<0.001$ and $p=0.01$, respectively). Univariate regression revealed six features independently association with KRAS mutation status: tumor circularity ($p=0.003$), solidity ($p=0.006$), eccentricity ($p=0.03$), coarseness ($p=0.03$), shade ($p=0.01$), and GLCM matrix standard deviation ($p=0.04$). A trained SVM model that included the tumor morphologic and texture features resulted in an area under the ROC curve of 0.95.

CONCLUSION

Quantitative tumor MRI features exhibit significant association with KRAS mutation and may contribute to predicting KRAS status in colon cancer patients.

CLINICAL RELEVANCE/APPLICATION

Tumor MRI radiomic analysis may aid in non-invasively assessing tumor genetic status and may aid in informing treatment choices and personalizing therapeutic decisions in patients with colon cancer.

SSK07-03 A Deep Neural Network for Liver Volumetry in Contrast Enhanced MRI

Wednesday, Nov. 29 10:50AM - 11:00AM Room: E353A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To establish a fully automated, reliable, and novel liver volumetry in contrast enhanced MRI based on deep learning algorithms.

METHOD AND MATERIALS

Data-sets of Gd-EOB-DTPA-enhanced liver MR images of 48 participants were assembled, consisting of 44 training and 4 validation cases. All imaging was performed using a clinical whole-body 3-T system (Magnetom Skyra, Siemens Healthcare). For segmentation, a T1-weighted volume-interpolated breath-hold examination (VIBE) sequences with fat suppression covering the entire liver, acquired during one breath-hold during the hepatobiliary phase (20 min after contrastinjection), was used.The current gold standard of manual liver segmentation was accepted as ground truth. Image Segmentation was performed by a resident physician with 5 years of experience in hepatobiliary imaging. Furthermore, 9 of the training images have been segmented by a second reader (5 years of experience) to determine the expert intraclass correlation coecient (ICC), dice index, and overlap. The neural network topology is loosely based on U-Net.

CONCLUSION

This study presents a fully automated liver volumetry scheme in MR imaging. It is evaluated in comparison to the gold standard manual volumetry. The neural network achieves a higher concordance with the ground truth than two expert readers agree in terms of ICC, dice index, and overlap. The results are highly competitive to current studies, in example Huynh et al. found an ICC of 0.94.

CLINICAL RELEVANCE/APPLICATION

This scheme provides an accurate automatic liver segmentation in MRI; hence it would serve as a useful tool for radiologists for treatment planning, especially for patients undergoing liver surgery.

SSK07-04 The Value of Texture Analysis on Perfusion-Weighted Magnetic Resonance Imaging for Malignancy Characterization of Hepatocellular Carcinoma

Wednesday, Nov. 29 11:00AM - 11:10AM Room: E353A

Participants
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PURPOSE

To explore the performance of texture analysis on perfusion-weighted magnetic resonance imaging (PW-MRI) in evaluating the malignancy of hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

Thirty-one surgically confirmed HCC patients were prospectively included and examined using a 3.0 Tesla MR scanner. The perfusion data was acquired using a prototype radial stack-of-stars three-dimensional spoiled gradient echo pulse sequence with golden-angle radial sampling schemes over the course of 6.25 minutes. Post-processing of PW-MRI data was performed on an in-housed software (Omini-Kinetics, GE Healthcare) to generate the Ktrans, Kep, Ve and AUC parametric maps using the Extended Tofts liner model. Texture analysis was then performed on those parametric maps using the same software. A total of 75 texture features were calculated for each perfusion results. The Edmondson-Steiner classification of HCC were histopathologically determined. Texture parameters were correlated with the Edmondson-Steiner grade of HCC. Receiver operation characteristic (ROC) analysis of discriminating low-grades (grade 1 and 2) from high-grades (grade 3 and 4) HCC was conducted for identified texture parameters.

RESULTS

The MinIntensity of Ktrans (r=-0.433, P=0.015), Kep (r=-0.409, P=0.022) and Ve (r=-0.384, P=0.033) maps, and the MinIntensity (r=-0.451, P=0.011), skewness (r=0.623, P<0.001), kurtosis (r=0.412, P=0.021) and uniformity (r=-0.55, P=0.001) of AUC maps showed week to moderate correlations with the Edmondson-Steiner grades of HCC. The skewness and kurtosis of AUC were significantly lower in low-grades HCC than in high-grades HCC, while the uniformity of AUC were significantly higher in low-grades HCC than in high-grades HCC. The areas under the ROC curve for the skewness, kurtosis and uniformity of AUC in differentiating high-grades from los-grades HCC were 0.868, 0.789 and 0.719, respectively.

CONCLUSION

Texture features based on PW-MRI, in particular the skewness of AUC, offer a potential avenue toward preoperative evaluation of HCC malignancy.

CLINICAL RELEVANCE/APPLICATION

Texture features of perfusion imaging can reflect the intratumoral heterogeneity of blood supply and cellular density, thereby

Texture features of perfusion imaging can reflect the intratumoral heterogeneity of blood supply and cellular density, thereby providing a reliable marker of lesion's potential malignancy.

SSK07-05 Hepatocellular Carcinoma: Texture Analysis of Preoperative CT Images as a Potential Marker of Disease-Free Survival

Wednesday, Nov. 29 11:10AM - 11:20AM Room: E353A

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PURPOSE

To investigate the performance of CT textural analysis (CTTA) in characterizing malignancy of hepatocellular carcinoma and predicting disease-free survival (DFS).

METHOD AND MATERIALS

Institutional review board approved this retrospective study, with a waiver of informed consent. From January 2009 to January 2015, 81 patients with single HCC underwent preoperative contrast-enhanced CT with same protocol and vender. Texture features of the largest tumor cross-sectional area from portal phase liver CT images were assessed by using TexRAD software which employed a filtration-histogram technique. Mean value of positive pixels (MPP), entropy, kurtosis, skewness, and standard deviation (SD) of the pixel distribution histogram were derived from the images without filtration and with filter values corresponding to fine, medium, and coarse texture scale. The texture features were compared between groups with different histologic grade using Student's t-test and Mann-Whitney test. Kaplan-Meier analysis was performed to determine the relationship between CTTA and DFS. The Cox proportional hazards model was used to assess the independence of texture parameters from other known clinical and imaging parameters.

RESULTS

SD and MPP quantified from fine to coarse texture on CT images showed significant associations with the histologic grade ($P<.05$). Univariate analysis identified most CT texture features across the different filters - fine, medium and coarse texture scales were significant univariate markers of DFS. Also a number of known clinical and imaging parameters such as tumor size, vascular invasion, the average intensity of tumor, the level of AFP and PIVKA were significant univariate markers of DFS. A Cox regression model including all significant univariate markers identified that CTTA (fine texture scale - kurtosis: $p=0.037$, skewness: $p=0.015$), and tumor size ($P<0.001$) were independent predictors of DFS.

CONCLUSION

CTTA could act as a prognostic biomarker in HCCs and play a key complementary role as an adjunct with other known clinical and imaging markers in better risk stratification of these patients.

CLINICAL RELEVANCE/APPLICATION

CTTA is a significant marker of disease-free survival in patients with HCCs. Their role as a prognostic biomarker can be a useful adjunct to improve stratification of HCC patients.

SSK07-06 HCC Treated With 90Yttrium Radioembolization: Can Pre-Treatment and 6week Post-Treatment Volumetric ADC Histogram Measurements Predict Subsequent Tumor Response?

Wednesday, Nov. 29 11:20AM - 11:30AM Room: E353A

Participants
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PURPOSE

To assess the potential of volumetric ADC (vADC) histogram measurements obtained before and 6 weeks (6w) post-treatment for prediction of hepatocellular carcinoma (HCC) response to 90Yttrium radioembolization (RE).

METHOD AND MATERIALS

22 patients (M/F 15/7, mean age 65y) who underwent lobar RE (right lobe n=15; left lobe n=7) were included. All patients underwent MRI pre-treatment and 6w and 6 months (6m) after RE using a routine liver MRI protocol including DWI. Two readers assessed tumor response 6m after RE in consensus. Definition of complete tumor response, partial tumor response, stable disease, and progression of HCC lesions was based on modified RECIST criteria (mRECIST) for each index tumor. vADC histogram parameters (mean, median, mode, min, max, kurtosis and skewness) were obtained by placing regions of interest (ROIs) on the ADC map covering the whole index tumors. One reader placed the ROIs at baseline and 6w after treatment. Changes in tumor vADC (ΔvADC) histogram parameters were calculated. Data was evaluated using Mann-Whitney U test and receiver operating characteristics

analysis.

RESULTS

26 HCC lesions (mean size 3.4±2.4 cm) were assessed (18 patients with 1 tumor, 4 patients with 2 tumors). Response at 6m was as follows: complete response (CR, 8 tumors), partial response (PR, 3 tumors), stable disease (SD, 13 tumors) and progression (PD, 2 tumors). vADC mean, median, mode (1.76-1.81 vs. 1.23-1.34 x10-3 mm2/s) and ΔvADC median and ΔvADC max (30-43% vs. 2-9%) at 6w were significantly higher in CR/PR vs. SD/PD (p=0.013-0.032), while there was no significant difference at baseline. vADC mean, median, ΔvADC mean and ΔvADC max at 6w were significant predictors of CR/PR (AUC 0.752-0.788; p=0.014-0.031) and of CR (AUC 0.750-0.861; p=0.004-0.046) after RE. vADC median threshold of 1.377 x10-3 mm2/s at 6w had a sensitivity of 81.8% and a specificity of 66.7% for prediction of PR/CR and ΔvADC median threshold of 19.2% had a sensitivity of 87.5% and a specificity of 83.3% for prediction of CR.

CONCLUSION

vADC mean, median, ΔvADC mean and ΔvADC max at 6w are significant predictors of subsequent response in HCCs treated with RE, while pre-treatment vADC did not have any predictive value.

CLINICAL RELEVANCE/APPLICATION

Our results suggest that vADC histogram measurements at 6w post RE are early biomarkers and allow prediction of treatment response.

SSK07-07 Development of CT Derived Biomarker for Gastrointestinal Stromal Tumor; Comparison with FDG-PET and DWI

Wednesday, Nov. 29 11:30AM - 11:40AM Room: E353A

Participants
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PURPOSE

Gastrointestinal stromal tumor (GIST) is the most common mesenchymal tumor of the gastrointestinal tract. It has been reported that 18F-Fluorodeoxyglucose-positron emission tomography (FDG-PET) and diffusion-weighted MRI (DWI) can be biomarkers to evaluate malignant potential of GIST. But considering availability of FDG-PET and DWI, development of CT derived biomarker would be valuable. The texture analysis such as fractal analysis of the medical image has been reported to be a potential biomarker for malignancies, reflecting structural heterogeneity of the tumor. The purpose of this study is to evaluate the usefulness of CT fractal analysis in preoperative assessment of malignant potential of GIST, comparing with FDG-PET and DWI.

METHOD AND MATERIALS

We retrospectively identified 43 patients (20 M / 23W; median age: 65) with GISTs who received FDG-PET, DWI, and contrast-enhanced (CE) CT before surgery. Tumor SUV and ADC were measured from FDG-PET and DWI. Regarding CT analysis, fractal analysis was applied to portal-phase CE-CT image with use of a plugin software of ImageJ (NIH), and fractal dimension (FD) of the tumor was measured. These tumor parameters were compared with the risk classification of GIST, and diagnostic values of these parameters for malignant potential of GIST were evaluated.

RESULTS

According to modified Fletcher classification, 9 patients were categorized as the high risk, and the other 34 cases were categorized as the very low or low risk (26) or the intermediate risk (8). Tumor FD of high risk group was significantly higher than that of the other risk groups (very low, low, and intermediate risk) ($P<0.05$). The areas under the ROC curves (AUCs) of tumor FD, ADC and SUV for prediction of high risk group were 0.84, 0.86 and 0.82, respectively. From this ROC curve analysis, 1.11(FD), 1.21(ADC), and 4.16(SUV) were the best cut-off value to predict the high risk GIST patients with a highest accuracy (85.7%, 71.4% and 83.3%, respectively).

CONCLUSION

Diagnostic value of CT fractal analysis for prediction of high risk GIST is comparable with FDG-PET and DWI. In terms of cost and availability, CT fractal analysis can be a most beneficial imaging biomarker for the management of GIST.

CLINICAL RELEVANCE/APPLICATION

CT fractal analysis can be a noninvasive, economical and widely applicable biomarker for preoperative risk stratification of GIST, and it would help select an optimal therapy for patients with GISTs.

SSK07-08 CT-Based Radiomic Signature Preoperatively Predicts Lymphovascular Invasion in Patients with Advanced Gastric Cancer

Wednesday, Nov. 29 11:40AM - 11:50AM Room: E353A

Participants
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PURPOSE

To develop and validate a machine learning based radiomics signature for preoperative prediction of lymph vascular invasion (LVI) in patients with advanced gastric cancer (AGC).

METHOD AND MATERIALS

In this ethical-approved retrospective study, we collected a primary cohort consisting of 152 patients gathered from July 2011 to December 2013 and a time-independent validation cohort consisting of 95 patients from January 2014 to July 2015. 273 texture features were extracted from venous-phase CT of AGC. Then, we adopted minimum redundancy maximum relevance (mRMR) algorithm to reduce the feature dimension as well as identify a radiomics signature for predicting LVI. We built a support vector machine (SVM) model to yield a quantitative risk score for LVI. The classification performance of the SVM model was evaluated by univariate analysis, multivariate analysis and receiver operator characteristics (ROC) analysis in the primary cohort and validated in the time-independent validation cohort.

RESULTS

The 5-feature-based radiomics signature was an independent predictor for LVI in AGC ($P<0.001$ for both primary and validation cohorts). The radiomics signature showed strong discriminatory power for LVI prediction with an AUC of 0.764 (95% CI: 0.685-0.843; sensitivity: 0.844; specificity: 0.618) in the primary cohort. In addition, the radiomcs analysis achieved competitive generalization performance with an AUC of 0.744 (95% CI: 0.640-0.848; sensitivity: 0.818; specificity: 0.600) in validation cohort.

CONCLUSION

Machine learning by means of SVM in combination with texture features can be used to associate with the status of LVI. The radiomics signature may serve as a potential non-invasive tool for the preoperative LVI prediction in patients with AGC.

CLINICAL RELEVANCE/APPLICATION

Machine learning based radiomics signature has potential in the preoperative non-invasive prediction of lymphvascular invasion and facilitate the clinical strategy.

SSK07-09 Comparison of Current Response Criteria in Patients with HCC Treat with Targeted Therapy Using a 3D Quantitative Analysis

Wednesday, Nov. 29 11:50AM - 12:00PM Room: E353A

Participants
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PURPOSE

The aim of this study was to compare existing available non-three-dimensional methods (Response Evaluation Criteria in Solid Tumors [RECIST], modified RECIST [mRECIST], European Association for Study of the Liver [EASL]) with three-dimensional (3D) quantitative methods of the index tumor as early response markers in predicting patient survival after targeted therapy.

METHOD AND MATERIALS

This study was a retrospective single-institution HIPAA-compliant. A total of 88 patients with hepatocellualr carcinoma (HCC) treated with targeted therapy was enrolled (in 76 men and 12 women; mean age, 61 years ± 7 [standard deviation] ; Range, 22-88 years). CT scans before and after targeted therapy were analyzed. Six response assessment methods (RECIST, mRECIST, EASL and 3D methods of volumetric RECIST [vRECIST], modified vRECIST [vmRECIST] and quantitative EASL [qEASL]) were used to classify all patients as responders or nonresponders by following standard guidelines for the uni- and bidimensional measurements and by using the formula for a sphere for the 3D measurements. 3D quantitative tumor assessments were performed using an in-house software prototype (3D Quantitative Imaging, MGH, USA).The Kaplan-Meier method with the log-rank test was performed for each method to evaluate its ability to help predict survival of responders and nonresponders. Uni- and multivariate Cox proportional hazard ratio models were used to identify covariates that had significant association with survival.

RESULTS

The 3D quantitative tumor assessments of vRECIST (hazard ratio,0.6; 95% confidence interval [CI]: 0.4, 1.2; P=0.03), vmRECIST (hazard ratio,0.6; 95% CI: 0.3, 0.9; P=0.04), and qEASL (hazard ratio,0.5; 95% CI: 0.3, 0.6; P=0.002) showed a significant difference in survival between responders and nonresponders groups, whereas the uni- and bidementional measurements of RECIST (hazard ratio,0.5; 95% CI: 0.3, 0.9; P=0.08), mRECIST (hazard ratio,0.6; 95% CI: 0.3, 1.0; P=0.07), and EASL(hazard ratio,0.7; 95% CI: 0.3, 0.8; P=0.06) did not show a significant difference between these groups.

CONCLUSION

Compared with the uni- and bidemensional measurements, the 3D-based imaging biomarkers vRECIST, vmRECIST and qEASL could

be used to predict patient survival early after targeted therapy.

CLINICAL RELEVANCE/APPLICATION

Volumetric quantification is sensitive to detect early change of HCC and to accurately assess treatment response.

SSK08

Gastrointestinal (Colon Cancer and CT Colonography)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: E353B

CT GI MR OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Judy Yee, MD, Bronx, NY (*Moderator*) Research Grant, EchoPixel, Inc
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Sub-Events

SSK08-01 Multilevel Determinants of Adenoma Detection Rate at CT Colonography (CTC) Screening: Association with Radiologist Experience and Patient-Related Factors

Participants
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PURPOSE

In a large randomized trial the overall adenoma detection rate appeared to be similar between CTC and sigmoidoscopy (FS). CTC achieved a higher detection than FS in the proximal colon, while the reverse was true for the distal colon. To assess the relationship between radiologist experience and adenoma detection rate at CTC screening.

METHOD AND MATERIALS

Post-hoc analysis of a RCT, examining the diagnostic performance of radiologists in relation with previous CTC experience. Radiologist experience was classified according to the total number of CTC performed before the trial (i.e, <200, 200-1,000, >1,000). Multilevel logistic regression was used to model the influence of reading volumes and patient characteristics on the probability to detect adenomas. Patient factors included gender, previous CRC screening, CRC family risk, and image/distension quality. Analyses were performed separately for each of the following lesions: all adenomas (ADR), distal adenomas (DADR), proximal adenomas (PADR), advanced histology (i.e. >=10-mm, villous histology or high grade dysplasia). A 6-mm cut-off was used for post-CTC referral to colonoscopy.

RESULTS

2593 CTC (1266 F; age, 58-60) were read by 7 radiologists. In detail, 1337 (51.5%), 584 (22.5%), and 672 (26.0%) were read by radiologists with reading volumes<200, 200-1000, and >1000, respectively. The average ADR, DADR and PADR were 8.0% (95% CI: 7.0-9.1%; range, 5.8-8.7%), 5.0% (95% CI:4.3-5.9%, range, 2.1-8.4%), and 5.1% (95% CI:4.2-6.3, range, 4.4-5.4%), respectively. Radiologist experience appeared to be related with DADR (OR, >1000 vs <=1000:1.49; 95% CI: 1.04-2.13), but not with PADR (OR,>1000 vs. <=1000:0.91; 95% CI:0.64-1.29). The association of radiologist experience with distal location appeared to be statistically significant also for advanced adenomas (OR,>1000 vs. <=1000, 1.73; 95% CI:1.08-2.88). In multivariate analysis, volumes>1000, male gender, excellent/good image quality and no previous colonoscopy were significantly associated with greater odds of detecting distal adenomas.

CONCLUSION

According to our data, distal adenomas, including those with advanced histology, could be missed by less experienced radiologists (<1000 CTC).

CLINICAL RELEVANCE/APPLICATION

High reading volumes, greater than 1000 CTCs, may be required to achieve high adenoma detection rates in the distal colon. Optimization of training methods is critical to ensure a consistent high-quality level at CTC screening.

SSK08-02 Effect of Iterative Model Reconstruction algorithm on Radiologist's Performance in CT Colonography

Wednesday, Nov. 29 10:40AM - 10:50AM Room: E353B

Participants

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PURPOSE

To assess radiation dose and image quality of CT colonography (CTC) at 100 kVp with iterative model reconstruction algorithm (IMR) at 20 mAs compared with filtered back projection (FBP) at 50 mAs.

METHOD AND MATERIALS

Thirty-two patients suspected with colon adenomatous polyp or adeno-carcinoma were enrolled in this study. All of patients underwent CTC examination at 50mAs in supine position and 20mAs with prone position with the same tube voltage at 100 kVp about two hours before fibro-colonoscope. Images were reconstructed using FBP and IMR. Two radiologists independently evaluated image quality. Qualitative image quality was assessed with a five-score scale. Image noise, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and effective radiation dose were recorded and calculated. Qualitative and quatitative values were analysed by using Wilcoxon signed rank test and the paired t test, respectively.

RESULTS

Totally 38 colon polyps or adeno-carcinoma were detected in fibro-colonoscope examination. For 20 mAs with IMR (A group) and 50 mAs with FBP (B group), there is no statistically significant difference in lesion detection (reader 1: 35/38 vs 36/38, and reader 2: 31/38 vs. 33/38, p>0.05). However, qualitative image quality scores (3.9 vs 2.5), image noise ([12.77± 0.91] HU vs. [50.04±5.45] HU), SNRs (3.13±0.28 vs. 1.02±0.20) and CNRs (81.42±6.11 vs. 19.93±1.46) were significantly superior of 20 mAs with IMR, respectively (p<0.05) . Compared with B group, radiation dose of A group decreased significantly (0.42±0.03 mSv vs. 1.07±0.12mSv).

CONCLUSION

Image quality of CTC using 20 mAs with IMR reconstruction could be comparable to 50 mAs with FBP at the same tube voltage while with no significant detection of poply, and radiation dose of the former was only 0.42 mSv, which was reduced by about 39.3%.

CLINICAL RELEVANCE/APPLICATION

This preliminary study helps to reduce the radiation dose of patients undergoing CTC examination with IMR algorithm.

SSK08-03 Feasibility of Computer-Aided CT Colonography in a Single-Position Reading

Wednesday, Nov. 29 10:50AM - 11:00AM Room: E353B

Participants
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PURPOSE

To evaluate the performance of computer-aided single-position reading of full-cathartic CT colonography (CTC) in detecting polyps from patients at average or high risk of colorectal cancer.

METHOD AND MATERIALS

A total of 266 CTC cases were sampled from a multi-center CTC trial for patients at average or high risk of colorectal cancer. The patients underwent cathartic bowel preparation with 2L polyethylene glycol solution and fecal tagging by 20mL sodium diatrizoate, followed by automated CO2 insufflation. A computer-aided detection (CADe) system trained with cases independent from this study was used to review the CTC cases. Two experienced readers (>=600 CTC cases reading experience) reviewed the cases for >=6 mm lesions in supine-only reading mode, in which only the supine scans of these cases were interpreted and CADe was used as a second reader. The per-patient sensitivity and area under the receiver operating characteristic curve (AUC) were compared in the detection of adenomas and carcinomas between the unaided and CADe-aided supine-only readings, and between the CADe-aided supine-only reading and the conventional unaided dual-position reading result of the original trial.

RESULTS

There were 35 and 28 patients with 6-9 mm and >=10 mm adenomas/carcinomas, respectively. The corresponding average per-patient sensitivities (AUCs) for CADe-aided supine-only reading were 82.9% (0.89) and 90.9% (0.95), respectively, whereas those of unaided dual-position reading were 82.9% (0.88) and 92.9% (0.96), respectively. The differences of sensitivities and AUCs at each size range were not statistically significant (sensitivities: Fisher's exact test, P>0.7; AUCs: two-sided t-test, P>0.3). For 6-9 mm lesions, the per-patient sensitivity (AUC) of CADe-aided supine-only reading was 82.9% (0.89), higher than that of unaided supine-only reading of 71.4% (0.85) (sensitivity: McNemar's test, P<0.01; AUC: one-sided t-test, P<0.05).

CONCLUSION

In full-cathartic CTC, CADe-aided single-position reading yields an equally high performance in detecting adenomas and carcinomas as that of conventional supine-prone reading. In single-position reading, the use of CADe significantly improves the detection of polyps 6-9 mm in size.

CLINICAL RELEVANCE/APPLICATION

Computer-aided single-position reading has potential to allow one-position scanning in CTC, thereby effectively halving the radiation

Computer-aided single-position reading has potential to allow one-position scanning in CTC, thereby effectively halving the radiation dose and reading time of conventional dual-position reading.

SSK08-04 Dual-Energy CT Colonography Using Dual-Layer Spectral Detector Computed Tomography: Feasibility of Virtual Monochromatic Imaging for Electronic Cleansing

Wednesday, Nov. 29 11:00AM - 11:10AM Room: E353B

Participants
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PURPOSE

We investigated the utility of virtual monochromatic imaging (VMI) using dual-layer spectral detector CT on the electronic cleansing in fecal-tagging CT colonography.

METHOD AND MATERIALS

This study included 30 patients who underwent fecal-tagging CT colonography performed on a novel dual-layer detector spectral CT scanner. Conventional 120-kVp images and VMI at 40-, 50-, and 60-keV were reconstructed. Quantitative image quality parameters, i.e. CT attenuation of tagged fluid and image noise, were compared and the visual image quality was scored on a four-point scale. We recorded the number of the colon segments with appropriate CT attenuation of tagged fluid (>= 300 HU) for each patient and used these data to compare the reconstructions. The performance of the electronic cleansing was also assessed semi-quantitatively using a four-point scale.

RESULTS

The mean CT attenuation of tagged fluid was significantly higher on VMI than conventional 120-kVp images. There was no significant difference in image noise among the reconstructions. The number of colon segments with appropriate CT attenuation of tagged fluid was significantly higher on VMI than conventional 120 kVp images. Significant higher score of the subjective image quality and the performance of the electronic cleansing were observed on VMI than conventional 120 kVp images.

CONCLUSION

With dual-layer spectral detector CT, the use of VMI can yield significantly better image quality of fecal-tagging CT colonography and improve the performance of the electronic cleansing.

CLINICAL RELEVANCE/APPLICATION

VMI using dual-layer spectral detector CT can improve image quality of fecal-tagging CT colonography and provide more accurate diagnostic information.

SSK08-05 Inter-Observer Agreement Using a Coding System for Reporting Virtual Colonoscopy

Wednesday, Nov. 29 11:10AM - 11:20AM Room: E353B

Participants
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PURPOSE

A coding system is utilised at our UK institution for reporting virtual colonoscopy/CT colonography (CTC) examinations. The C coding refers to the intra-colonic findings, whereas the E coding refers to extra-colonic findings, both on a scale from 1 to 5. The purpose of this study was to validate the coding system by assessing the inter-observer variability of two independent readers using the same coding system to summarise the CTC findings.

METHOD AND MATERIALS

A retrospective study was performed of all CTCs in our University Teaching Hospitals NHS Trust in the UK, which performs the largest number of examinations at any single institution throughout Europe, over a 3 month period (01/07/16 - 30/09/16). Our standard practice is for each study to be read initially by an advanced practitioner radiographer with a final report issued by a consultant radiologist. The report coding issued by the different readers was analysed and compared.

RESULTS

626 CTCs (mean age 69 years) were selected for inclusion. 57 studies were excluded either as they were not coded, not read by a radiographer prior to consultant report or rated as an inadequate study by either reader. The percentage agreement between radiographer findings and radiologist report was 92.3% for C coding and 50.6% for E coding. Interobserver agreement Kappa statistic was calculated to be 0.77 (95% CI 0.703-0.830) for C coding and 0.27 (95% CI 0.206-0.324) for E coding.

CONCLUSION

There is high inter-observer agreement between medical and non-medical readers for C coding suggesting it is a precise and easy to follow method of classifying colonic findings. The greater variability for E coding may be due to difficulty in classifying extra-

colonic findings but also reflective of the skill set between the two types of readers.

CLINICAL RELEVANCE/APPLICATION

The use of a report scoring system highlights important CTC findings so that the clinical teams can expedite arrangement of the appropriate further management and if necessary multi-disciplinary team discussion. The study shows that our scoring system is easy to use and demonstrates high inter-observer agreement for the intr-colonic findings, which is required for the system to be valid.

SSK08-06 Assessment of the Neoadjuvant Chemoradiation Outcomes in Patients with Clinical T1/T2 Rectal Cancer Using the MRI Tumor Regression Grade

Wednesday, Nov. 29 11:20AM - 11:30AM Room: E353B

Participants
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Joonseok Lim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To analyze magnetic resonance imaging (MRI) tumor regression grade (mrTRG) for predicting the outcomes after the neoadjuvant chemoradiation in patients with clinical T1/T2 rectal cancer.

METHOD AND MATERIALS

Between 2012 and 2016, we retrospectively registered 39 patients with clinical T1/T2 rectal cancer who had undertaken either the total mesorectal excision (TME) or local excision after the neoadjuvant chemoradiation. Initial rectal MRI was analyzed to determine the mural involvement of the primary tumor (partial or transmural involvement) and both initial and post-treatment rectal MRI were reviwed for mrTRG. Surgical pathologic assessment including Mandard grade was used to evaluate the tumor regression after the neoadjuvant treatment and Mandard grade 1 was considered as pathologic complete response (pCR). Associations of mrTRG and the degree of mural involvement with Mandard grade and pathologic T stage (pT) were analyzed.

RESULTS

Out of 39 patients, 20 patients had mrTRG 1 and 19 patients had mrTRG 2-4 (mrTRG2=11, mrTRG3=6, mrTRG4=2). Sixty-five percent (13/20) of mrTRG 1 patients showed pCR, and this positive predictive value of mrTRG 1 was higher than observed pCR rate (18/39, 46.2%). The odds of accomplishing pCR were 5.2 times higher for mrTRG 1 than they were for mrTRG 2-4 (95% confidence interval (CI): 1.3 - 20.5, p=0.019). Univariate analysis of the degree of mural involvement indicated that the difference in probability of pCR did not reach the significance (odds ratio (OR)=1.1, 95% CI=0.3-3.9, p=0.882). Ninety percent (18/20) of mrTRG 1 patients had early stage cancer (pT0, pTis and pT1) after the preoperative chemoradiation. Univariate analysis demonstrated that mrTRG1 group was significantly more likely to have early stage cancer than was mrTRG2-4 group (OR=8.1, 95% CI=1.5-45.1, p=0.017), while the OR of partial involvement of the primary tumor was not statistically significant (OR=3.6, 95% CI=0.8-16.3, p=0.103).

CONCLUSION

mrTRG 1 can be used as a supportive factor to predict the complete response after the neoadjuvant chemoradiation in patients with clinical T1/T2 rectal cancer. Moreover, mrTRG seem to deduce pathologic early stage rectal cancer which can be the candidate for local excision rather than TME.

CLINICAL RELEVANCE/APPLICATION

mrTRG can be a supportive tool to predict the complete response and to identify pathologic early stage cancer after the neoadjuvant chemoradiation in clinical T1/T2 rectal cancer patients.

SSK08-07 Influence of Iterative Reconstruction and Slice Thickness on Texture Analysis

Wednesday, Nov. 29 11:30AM - 11:40AM Room: E353B

Participants
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PURPOSE

To assess the variability of texture analysis parameters on CT scans depending on the iterative reconstruction technique and the slice thickness.

METHOD AND MATERIALS

To date, ten patients (M/F=4/6, mean age 71 yo) with liver metastases were retrospectively included in this study (1 patient with a GIST, 1 patient with a pancreatic cancer, 8 patients with a colorectal cancer). All patients had a CT-scan at a portal venous phase after injection of Iomeron 350, using a Philips system (ICT256). The standard reconstruction parameters included an iDose4 reconstruction with a 2 mm-slice thickness. Four additional reconstructions were performed: iDose4 with 1 and 5 mm-slice thickness, and iDose2 and 6 with a 2 mm-slice thickness. Using LIFEx software v3.0, a region of interest (ROI) was drawn by one radiologist, on one of the reconstruction. The ROI contained the largest diameter of the liver metastases (max 5 lesions /patient, lesion diameter > 1cm). The ROI was copied and pasted on the images from other reconstructions. Mean, standard deviation, skewness, kurtosis and entropy of each ROI were obtained. Variability between iterative reconstructions and slice thicknesses was

assessed using coefficient of variation (CV), and Bland and Altman limits of agreement (BALA) (percentage of difference).

RESULTS

Forty-eight liver metastases were analyzed. Between iterative reconstructions, all the parameters, except skewness, had a good reproducibility (CV<8%). The mean was the less variable parameter with a CV<1% and BALA thinner than [-4.38%;2.36%], while skewness was the less reproducible parameter with a CV of 25.5% and BALA until [-135.3%;48.18%]. For all texture parameters, the variability was higher between slice thicknesses than between iterative reconstructions, but still acceptable for all parameters (CV<18%) except for skewness. Skewness had a very low reproducibility between slice thicknesses with a CV of 954% and BALA until [-846.5%;1103%].

CONCLUSION

Texture parameters, mostly skewness, show some variability depending on the iterative reconstruction and moreover on the slice thickness.

CLINICAL RELEVANCE/APPLICATION

Texture analysis is a more and more used method, especially for tumor follow-up and assessment of treatment response. Variability related to the CT acquisition parameters needs to be taken into account to avoid incorrect conclusion.

SSK08-08 Changes in the Diagnostic Accuracy of Radiologists and Residents for Rectal Cancer Staging by using Diffusion Weighted Imaging

Wednesday, Nov. 29 11:40AM - 11:50AM Room: E353B

Participants
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PURPOSE

To analyze the influence of Diffusion Weighted Imaging (DWI) on the diagnostic accuracy for the staging of Rectal Cancer (RC), regional lymph nodes (LN) and primary tumor (T) in Radiologists with different degree of expertize

METHOD AND MATERIALS

The study included 50 patients with Magnetic Resonance Imaging (MRI) for RC staging, all with same technique (1.5 T) and later total mesorectal excision. Initial diagnosis (32) and post-neoadyuvancy cases (28, MRI after treatment) were included (ID and PN respectively). The histological stage was used as Gold Standard. 10 Radiologist reviewed individually all cases, blinded to any data but the presence of RC: 3 experienced in RC staging (ER); 3 experienced in other areas (NER); and 4 Residents (RR). Each reading had 2 phases: 1st analyzing just T2 and T2 High Definition sequences (T2HD); after a month washout period, 2nd reading with DWI and T2HD. The staging followed AJCC 7th ed. guidelines. Malignant LN were defined as heterogeneous internal signal/irregular borders. The results were pooled by experience groups for statistical analysis. Area under ROC curves were used to determine accuracy of positive LN, stage greater than I and T greater tan 2. Also, ponderated Kappa with respect to the histological results. All calculations were made in the different reviews and then made again after spliting them into ID and PN patients groups.

RESULTS

Due to their length the results have been summarized in the attached charts. Differences after use of DWI (increase/decrease) in group accuracy and Kappa regarding Gold Standard are shown.

CONCLUSION

There is a significant decrease of accuracy for local and N staging in all Radiologists with the use of DWI (also present in Kappas), more uniform in the experienced ones but for local stage in PN cases. Residents' accuracy for N highly increase in ID cases, while decreasing in PN. This could be due to a better detection of the LN, but with difficult interpretation of the changes secondary to treatment. On the contrary, all Radiologists show an increase in accuracy for T stage with DWI in ID cases (also PN in experienced ones), while decreasing in the rest. This could be due to a decrease in the overstaging of desmoplastic reaction or fibrosis in PN, with difficult interpretation of the latter for unexperienced ones.

CLINICAL RELEVANCE/APPLICATION

DWI could be functioning as a confounding factor in RC, especially in N and global staging.

SSK08-09 Role of CT-Colonography for Detection and Characterization of Synchronous Proximal Colonic Lesions in Patients with Stenosing Colorectal Cancer

Wednesday, Nov. 29 11:50AM - 12:00PM Room: E353B

Participants
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PURPOSE

To evaluate the clinical usefulness of CT Colonography (CTC) immediately after incomplete Optical Colonoscopy (OC) for occlusive colorectal cáncer (CCR), in the detection of synchronous carcinomas and advanced adenomas and their impact in the management of patients.

METHOD AND MATERIALS

Posterior to incomplete OC,165 patients (mean age of 71 years) with occlusive colonic carcinoma underwent subsequent CTC. 135 patients had distal CRC and 29 proximal. Experienced radiologists prospectively analyzed the presence of syncronous carcinomas and colorectal polys. 164 patients underwent colorectal resection. We retrospectively analyzed the surgical outcome and the follow-up of patients.

RESULTS

Seventeen syncronous tumors were detected in 11 patients (6,6%). Eight in the proximal and nine in distal colon. Eigth patients had only one synchronous tumor and three patients had several tumors (2, 3 and 4 synchronous carcinomas, respectively). Nineteen polypoid lesions > 2 cm were detected in 10 patients, seventeen were tubulo-villous adenomas with high-grade displasia and two were tubulo-villous adenomas with low-grade displasia. Twenty one patient (12.72%) had pediculated and sesil polyps in the remainig colorectum not explored in the OC, that required OC and exeresis between 1 and 6 months after surgery. After CTC, surgeons modified initial surgical plan in 22 patients (13,3%) and the follow-up in 25 patients (15,15%). 13 patients with obstructive cancer couldnt be correctly assesed, 8 because of defficient colonic distension and 5 due to great amount of feces. Gross lesions were discharged, nevertheless we recommended vigilance during surgical procedure and posterior.

CONCLUSION

Detection of all synchronous CRC and adenomatous polys, before surgery is very important, as the number and location of tumors may affect the surgical procedure and the subsequent management of patients. In our series, CTC changed surgical management and surveillance in 47 patients (28,45%). CTC is a technically robust and the most practical method to evaluate the colon proximal to an occlusive cancer, even in patients with metallic stent placement in acute neoplastic colonic obstruction.

CLINICAL RELEVANCE/APPLICATION

This exhibit exposes the use of CT-Colonography to evaluate all the colon in obstructing colorectal cancers with incomplete Optical Colonoscopy and their ability to detect synchronous cancers and advanced adenomas.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSK09

Genitourinary (New Methods in Prostate Imaging and Intervention)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: E450B

GU MR OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSK09-01 A New System to Spatially Align In Vivo MRI with Ex Vivo MRI and Whole-Mount Histopathology for Integrated Prostate Cancer Research

Participants
Holden H. Wu, PhD, Los Angeles, CA (*Presenter*) Institutional research support from Siemens
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PURPOSE

The development and validation of multi-parametric MRI (mp-MRI) for prostate cancer (CaP) diagnosis relies on comparisons with histopathology (HP) and accurate spatial alignment is critical. In this study, we develop and evaluate a new system that combines patient-specific molds and ex vivo MRI of the resected prostate to align in vivo (InV) MRI, ex vivo (ExV) MRI, and whole-mount (WM) HP in CaP patients.

METHOD AND MATERIALS

Patients who underwent radical prostatectomy were studied. InV-MRI was obtained prior to surgery (mean = 77 days) at 3 T (Trio/Verio/Skyra/Prisma, Siemens) using an external array and an endorectal coil. The protocol included 3D T2w MRI, on which the prostate was contoured in 3D to print a patient-specific mold before surgery. Within 30 min after surgery, the fresh whole prostate specimen was placed in a patient-specific mold and underwent ExV-MRI at 3 T (Prisma, Siemens) using a knee coil. The protocol included high-resolution T2w MRI to evaluate spatial alignment with in vivo 3D T2w MRI and WM slides. Immediately afterwards, the prostate was sectioned in the mold along slits (4.5-mm steps) to create WM slides. InV-MRI was registered to ExV-MRI using a mutual information based rigid 3D algorithm. A non-rigid algorithm was used to register WM slides to ExV and InV MRI. A radiologist matched 2D slice locations and annotated corresponding non-cancerous landmarks on all three image sets. The WM to ExV-MRI slice offset error was recorded. In the matched slices, 2D target registration error (TRE) between the landmarks was calculated.

RESULTS

In all patients (N=10, mean 64.7 years, mean PSA 6.17 ng/ml), ExV-MRI was successfully completed (mean time 116 min). The mold and ExV-MRI had no adverse impact on WM HP. The mean slice offset error was 1.36 mm (<1.5-mm MRI slice thickness). Mean 2D TRE was (mean±SD): 1.9±1.1 mm for InV vs. ExV MRI, 1.6±0.9 mm for WM vs. ExV MRI, and 2.1±1.4 mm for WM vs. InV MRI.

CONCLUSION

We have successfully integrated the new system with our clinical workflow to achieve excellent spatial alignment among InV-MRI, ExV-MRI, and WM slides with 2D TRE of 1-2 mm. This can enable MRI-WM comparisons and integrated research in CaP.

CLINICAL RELEVANCE/APPLICATION

The new system achieves excellent spatial alignment among in vivo MRI, ex vivo MRI, and whole-mount histopathology for integrated research in prostate cancer.

SSK09-02 An Objective Tool for Diagnosing Prostate Cancer and Benign Prostatic Hyperplasia: Radiomics Features Extracted from Diffusion-Weighted Imaging

Wednesday, Nov. 29 10:40AM - 10:50AM Room: E450B

Participants
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PURPOSE

To evaluate the usefulness of radiomics features indistinguishing prostate cancer (PCa) from benign prostatic hyperplasia (BPH) based on diffusion-weighted imaging (DWI) sequence without subjective factors.

METHOD AND MATERIALS

This retrospective study was approved by local IRB, and written informed consent was waived. 200patientswere enrolled followed by surgery or biopsy within one month in this study(100 were PCa and 100 were BPH)High-throughput extraction and analysis of the radiomics features based on DWI included five procedures: 1) 2D region of interest (ROI) was sketched along the edge of the whole prostate at the slice with the maximum diameter of the lesion by a 3-year experienced radiologist.2) 396 radiomics features, including size and shape based-features, histogram, GLCM as well as GLRLM texture features were automatically generated from A.K.(Analysis-Kinetics, GE Healthcare). 3) Feature reduction was conducted based on Kruskal-Wallis test and auto-correlation analysis with $|r|>0.9$ using R.4)90 PCa and 90 BPH selected randomly in 200 patients were used for supervise Model-learning using Logistic Regression. 5)10 PCa and 10 BPH were used and compared with pathologic diagnosis and receiver operating characteristics (ROC) were used to assess the efficiency of model.

RESULTS

K-W test showed that 233 radiomic parameters had significant difference between PCa and BPH groups, auto-correlationanalysis reduced them into 47 potential predictors which used for diagnostic model building. The area under the curve (AUC) of Logisticregression model in discriminating the two groups was 0.894, sensitivity and specificity were respectively 92.2% and 86.7%, with 85% diagnosis accuracy rate.

CONCLUSION

Radiomics features of DWI performed well indistinguishing PCa from BPH, which could help objectively and quantitatively evaluate tumor heterogeneity, and have prospect of being an independent &non-invasive efficient diagnostictool.

CLINICAL RELEVANCE/APPLICATION

Compared with traditional manual method, Radiomics features not only could lighten the visual fatigue for radiologist but also raise the precision of diagnosis.

SSK09-03 Diagnosing Prostate Cancer through Non-Invasive Estimation of Prostate Tissue Composition Using Hybrid Multidimensional MRI

Wednesday, Nov. 29 10:50AM - 11:00AM Room: E450B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

This study proposes to use Hybrid Multidimensional MRI (HM-MRI) to measures the change in ADC and T2 as a function of TE and *b*-value, respectively. This interdependence is used as a source of information about the underlying tissue microstructure. Specifically, we analyzed HM-MRI data to identify signal contribution from epithelial, stromal and luminal compartments in each image voxel. We evaluated whether this compartmental analysis can distinguish prostate cancer (PCa) from normal tissue.

METHOD AND MATERIALS

Patients (n=21) with confirmed PCa underwent preoperative 3T MRI. Axial images using HM-MRI were acquired with TE = 47, 75, 100 ms and *b*-values of 0, 750, 1500 s/mm2, resulting in a 3×3 array of data associated with each voxel. Volumes of tissue components- stroma, epithelium and lumen were calculated by fitting the hybrid data to a three compartment signal model, with distinct ADC and T2 associated with each compartment. Volume fractions, and conventional ADC and T2 were measured for ROIs on sites of prostatectomy verified malignancy (n=28) and normal tissue (n=71). ROC analysis was used to evaluate the performance of various parameters in differentiating PCa from benign tissue.

RESULTS

HM-MRI data from PCa showed significantly increased fractional volumes of epithelium (48.8±9.2 vs 23.2±7.1%) and reduced lumen (14.0±5.2 vs 26.4±14.1%), stroma (37.2±9.1 vs 50.5±15.7%), ADC (0.86±0.18 vs 1.30±0.23μm2/ms) and T2 (76.3±22.9 vs

104.2±47.1ms) as compared to normal tissue. These trends and values measured by HM-MRI are similar to those reported in previous histological studies. The volume fractions of epithelium (0.65), stroma (-0.44) and lumen (-0.39) show significantly higher Spearman correlation coefficient with Gleason score as compared to T2 (-0.29) and ADC (-0.32). Area under the ROC curve was highest for epithelium (0.99), followed by lumen (0.80), stroma (0.79) and T2 (0.71).

CONCLUSION

Fractional volumes of prostatic lumen, stroma, and epithelium change significantly when cancer is present. These parameters can be measured non-invasively using HM-MRI and these novel quantitative parameters have the potential to improve PCa diagnosis and determine the aggressiveness of PCa.

CLINICAL RELEVANCE/APPLICATION

Prostate tissue composition estimated non-invasively using HM-MRI has better diagnostic accuracy of detecting PCa compared to conventional T2 and ADC values.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Aytekin Oto, MD - 2013 Honored EducatorAytekin Oto, MD - 2017 Honored Educator

SSK09-04 Temporal Changes in MRI Appearance of the Prostate after Focal Ablation

Wednesday, Nov. 29 11:00AM - 11:10AM Room: E450B

Participants
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PURPOSE

The purpose of our study was to retrospectively evaluate and categorize temporal changes in MRI appearances of the prostate in patients who underwent focal therapy with MRI follow up.

METHOD AND MATERIALS

The Institutional Review Board approved this retrospective study and waived the requirement for informed consent. Forty-two patients (median age 61; 48-76 years) with low-to-intermediate-risk, clinically organ-confined prostate cancer underwent focal ablation therapy from 2009 through 2014. Two radiologists reviewed post-treatment MRIs (n=88) and categorized imaging features blinded to the time interval between the focal therapy and the follow-up MRI. Inter-reader agreement was assessed (kappa) and generalized linear regression was used to examine associations between imaging feature being present/absent and days between ablation and MRI.

RESULTS

Inter-reader agreement on MRI features ranged from fair to substantial. The presence of edema on MRI was found at the shortest median time interval after ablation (15-22d; $p<0.001$), followed by rim enhancement of the ablation zone (18-23d), a hypointense rim around the ablation zone on T2-weighted images (49-54d) and the presence of an appreciable ablation cavity (49-55d; all $p<0.05$). The formation of a T2-hypointense scar (446-461d) and enhancement of the ablation zone/scar (216-610d) were found to be present on later MRI scans for one reader.

CONCLUSION

The MRI appearance of the prostate after focal ablation changes substantially over time. Identification of temporal patterns in the appearance of imaging features should help radiologists distinguish normal MRI findings from possible recurrence and reduce image interpretation variability and errors when assessing post-therapeutic scans.

CLINICAL RELEVANCE/APPLICATION

The identification of distinct imaging features on prostate MRI after ablation with distinct temporal patterns allows for a more consistent language among radiologists and could reduce variability and errors when assessing post-therapeutic scans.

SSK09-05 Multiplexed Sensitivity-Encoding (MUSE) Reconstructed Multi-Shot Diffusion Weighted Imaging in Patients with Prostate Cancer: Preliminary Study on Image Quality and Apparent Diffusion Coefficient

Wednesday, Nov. 29 11:10AM - 11:20AM Room: E450B

Participants
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PURPOSE

Multiplexed Sensitivity-Encoding (MUSE) is a new reconstruction algorithm for multi-shot diffusion weighted image (msDWI) without using navigator echo to correct motion-induced phase error. The purpose of this study was to prospectively evaluate the image quality and apparent diffusion coefficient (ADC) of high-spatial resolution msDWI reconstructed with MUSE in patients suspected with prostate cancer.

METHOD AND MATERIALS

Fifteen consecutive patients clinically suspected with prostatic cancer (median 72 years old, range 55 - 80) underwent 3-T MR imaging using T2 weighted image, single-shot DWI (ssDWI; matrix, 96 x 96) and MUSE-reconstructed msDWI (matrix, 192 x 192) acquired with 4-shot interleaved echo-planar imaging. Both DWI were acquired with FOV of 22 cm, thickness of 4 mm, and b-value of 50 and 800 mm2/s. ADC maps were constructed for both DWI. Two radiologists blindly and independently assessed the image quality of DWI (b = 50, 800) and ADC map by comparing ssDWI and msDWI on image noise, anatomic delineation, distortion, artifact, and overall image quality with a 5-point scale. ADC values were measured in transitional and peripheral zone (TZ and PZ). Wilcoxon rank-sum test, kappa coefficient and paired t test was used to compare the score, inter-observer concordances and ADC value.

RESULTS

The scores of anatomic delineation of msDWI (b = 50, 800) and msADC map were significantly better than a single-shot image, and the scores of image noise were significantly worse for multi-shot image by 2 radiologists ($p < .05$, respectively). The score of overall image quality of msDWI (b = 50) was significantly better than ssDWI by 2 radiologists ($p = .001$, for both), but there were no significant differences for DWI (b = 800) and ADC map. Distortion and artifact were not significantly different between msDWI and ssDWI. The inter-observer concordances were poor to good (k = .074 - .770). ADC values of msDWI and ssDWI were not significantly different for TZ and PZ ($p = 0.47$ and 0.70).

CONCLUSION

The msDWI reconstructed with MUSE and its ADC map significantly improved anatomical delineation of the prostate, although the technique increased image noise. ADC values were not significantly different between ssDWI and msDWI.

CLINICAL RELEVANCE/APPLICATION

Evaluation of the prostate can be improved with high-spatial resolution msDWI reconstructed with MUSE, which is a promising technique for the detection and diagnosis of prostate cancer.

SSK09-06 Radiomics on Contrast-Free Bi-Parametric MRI Achieves Improves Prediction of Significant Prostate Cancer Compared to Clinical PI-RADS Version 2 Interpretation

Wednesday, Nov. 29 11:20AM - 11:30AM Room: E450B

Participants
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PURPOSE

To apply radiomics and machine learning (ML) to PI-RADS version 2 lesions and assess whether radiomics alone or the addition of radiomics improves predictive performance.

METHOD AND MATERIALS

In 194 consecutive patients examined on a 3T MRI system 253 PIRADSv2 lesions were identified and manually segmented on ADC/b-value of 1500 s/mm2 and T2-weighted images (segP). Patient were subsequently undergoing MRI-TRUS fusion biopsy with median 23 systematic cores and 4 targeted cores per lesion. In addition, on the basis of the biopsy results, retrospective PI-RADS assessment (PIRADSv2R) and manual lesions segmentation of the MR index lesion was performed manually by an experienced radiologist (segR). A total of 1073 quantitative radiomics features [including first-order, volume shape features, and texture features] were automatically extracted. The prediction of clinically significant Cancer (csPC) (GS 3+4 and 4+3 or higher) by PIRADSv2 assessment was compared to different ML approaches to integrate radiomics data (random forest, parameter normalization, training on segP/segR). Performance was assessed using bootstrap. The number of biopsies spared was assessed on a lesion and patient level.

RESULTS

A cut-off >=3 for PIRADSv2 was used. Radiomics Models were evaluated at the PIRADSv2 sensitivity, which was 96-97% in all cases. On a per-lesion basis PIRADSv2 achieved a specificity of 20% compared to 39% for the best ML model (RF trained using segR at PIRADSv2R cut-off of 4 including normalization, for GS4+3 prediction), which would have saved 42.3 biopsies. On a per-patient basis the model increased specificity from 23% to 37% which would have saved 23 patients a biopsy. Excluding the transitional zone, specificity increased from 41% to 52% for lesions, saving 11.2 biopsies and from 48% to 59% for patients saving

14.2 biopsies for GS3+4 prediction. Figure 1 demonstrates improved performance of the best ML model over PI-RADSv2, especially in the important high sensitivity range.

CONCLUSION

Radiomics and ML improve predictive performance compared to PI-RADS version 2 when applied to clinically selected lesions. The potential of radiomics to support clinical decision making is shown. Our results motivate the evaluation of this approach in larger and prospective cohorts.

CLINICAL RELEVANCE/APPLICATION

The potential application of the addition of radiomics to the clinical evaluation of PI-RADS lesions should be evaluated in a prospective setting.

SSK09-07 Towards Improved Gleason Score Prediction Using 18F-FACBC (Fluciclovine) PET and MRI: Evaluation of Advanced Post-Processing Methods Using Machine Learning

Wednesday, Nov. 29 11:30AM - 11:40AM Room: E450B

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

To evaluate the potential of advanced post-processing methods for 18F-FACBC (Fluciclovine) PET and MRI in the characterization of prostate cancer.

METHOD AND MATERIALS

Twenty one patients with histologically confirmed prostate cancer (PCa) scheduled for robotic-assisted prostatectomy underwent PET/CT immediately after injection of 369 ±10 MBq 18F-FACBC followed by PET/MRI (ClinicalTrials.gov Identifier: NCT02002455). MRI of PET/MRI consisted of T2-weighted imaging (T2w), two separate diffusion weighted imaging (DWI) acquisitions, second order rotating frame (RAFF) imaging, and T2 mapping. A separate 3T mpMRI consisting of T2w, three DWI acquisitions, proton magnetic resonance spectroscopy (1H-MRS) and dynamic contrast enhanced (DCE) imaging was acquired within a week of the PET scans. DWI was post-processed using kurtosis (ADCk, K), mono- (ADCm), and biexponential functions (f, Dp, Df) while Logan plots were used to calculate volume of distribution (VT). Logistic Regression with l2 normalization and leave-pair out cross validation (LPOCV) based area under the curve (AUC) values were used to estimate the potential of the quantitative parameters and their combination to predict Gleason score group (3+3 vs >3+3). Recursive feature elimination technique in the cross-validation loop was applied to exclude the bias of the model performance. In total, 16 unique PET (Vt, SUV) and MRI derived quantitative parameters were evaluated. Whole mount prostatectomy sections were used as "ground true".

RESULTS

The RAFF, monoexponential and kurtosis derived parameters had LPOCV AUC in the range of 0.72 to 0.82 while the corresponding value for VT was 0.85. T2 mapping, 1H-MRS ((choline+creatine)/citrate)) and DCE-MRI (Ktrans, Ve) derived parameters had the lowest LPOCV AUC in the range of 0.33 to 0.60. Most frequently selected parameters in each round of the cross-validation were VT, ADCk (0-2000 s/mm2, 12 b values), ADCm (0-1500 s/mm2, 2 b values), ADCm (0-500 s/mm2, 5 values), and K (0-2000 s/mm2, 12 b values) which demonstrated LPOCV AUC of 0.91.

CONCLUSION

Quantitative models using DWI and RAFF derived parameters led to improved PCa characterization. The added value of 18F-FACBC PET appears to be limited.

CLINICAL RELEVANCE/APPLICATION

18F-FACBC (Fluciclovine) PET has a power to predict Gleason score but adds little value to DWI and RAFF derived parameters.

SSK09-08 Computer-Aided Diagnosis for Prostate Cancer Detection in Multiparametric MRI: Influence on Reader Performance

Wednesday, Nov. 29 11:40AM - 11:50AM Room: E450B

Participants
Ge Gao, MD, Beijing, China (*Presenter*) Nothing to Disclose
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Rui Wang, PhD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine the interaction between computer-aided diagnosis (CAD) and readers with varying levels of experience in the interpretation of multiparametric prostate MR imaging with PIRADS v2.

METHOD AND MATERIALS

The institutional review board waived the need for informed consent. 64 patients (PCa=35; nonPCa=29) who were suspected of PCa and underwent mpMRI with subsequent biopsy or prostatectomy within 3 months were involved in this retrospective study. 6 readers were divided into 3 groups according to their experience in prostate imaging. Unknown the pathologic diagnosis, readers were asked to detect up to 3 lesions and graded 1-5 score according to PI-RADS v2 separately first without CAD and subsequently with CAD. Interreader agreement was assessed. According to histologic-radiologic correlation, the effect of CAD was evaluated by using ROC curve and Z test on patients and lesions basis. Wilcoxon signed ranks test were used to compare the diagnostic time and confidence with and without CAD. Furthermore, the requirement for CAD was also evaluated.

RESULTS

the AUC of stand-alone CAD was 0.918±0.036, and the spearman correlation coefficient between predictive values and PI-RADS scores was 0.706(P<0.01). Based on lesions, the AUCs of 6 readers were improved from 0.697-0.868 to 0.778-0.921 and the improvements were better than patient basis analysis. While the difference wasn't significant(P>0.05). Among 3 groups, the difference of AUCs between less experienced and experienced readers was significant without CAD, while with CAD, the difference was not significant. Besides, the interreader agreement and diagnostic confidence was improved significantly with CAD assisted. The rates of requirement for CAD were rising with reader's experience reduce. The average interpretation time of each case required an additional 0.8 minutes.

CONCLUSION

Integrating CAD into PCa mpMRI diagnostic process as a second reader, the performance of less experienced readers could be improved and similar with experienced readers. Additionally, with the reducing of experience, the requirement for CAD was rising.

CLINICAL RELEVANCE/APPLICATION

The CAD assisted can significantly improve the performance of less experienced readers in prostate mpMRI interpretation, and much better in lesion detection and evaluation than it in patient, which indicate that CAD could be a promising method for detecting a target lesions for prostate biopsy.

SSK09-09 Detection of MRI "Index Lesion" with mpMRI-TRUS Fusion-Targeted Prostate Biopsy: Does it Correspond to Histopathology?

Wednesday, Nov. 29 11:50AM - 12:00PM Room: E450B

Participants
Maurizio Del Monte, Montelanico, Italy (*Presenter*) Nothing to Disclose
Marcello Domenico Grompone, MD, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose
Vincenzo Salvo, MD, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose
Martina Pecoraro, MD, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine the histopathological correspondence of MRI "index lesion" between multiparametric magnetic resonance imaging (mpMRI)/Transrectal ultrasonography (TRUS) fusion biopsy and radical prostatectomy.

METHOD AND MATERIALS

Institutional review board approval; Informed consent was obtained from all individual participants included in the study. This prospective study has been performed on a cohort of 142 biopsy naive patients aged 45-76 years, with elevated PSA level, recruited from October 2015. Diagnostic 3T MRI was performed and the index lesion is identified as being the one with the highest PI-RADS v.2 score and 1-3 additional "potential lesion" with a lower PI-RADS (v.2) and/or smaller volume are defined as 'Non Index lesion'. A maximum of 2-3 biopsies per lesion have been carried out and pathologic results acquired. Patients found to be positive undergo radical prostatectomy.

RESULTS

Prostate cancer was detected in 142/142 patients with a cancer detection rate being 100%. MR index lesion and the pathology report show a 100% correspondence concerning the lesion dimensions. MR/TRUS guided biopsy and the pathology report show a 86% correspondence with a relative risk of 0.94 and a p value <0.01, concerning Gleason Score Determination; and a 72% correspondence with a relative risk of 0.69 a p value <0.01, concerning the highest Gleason Score. Missed lesions on MRI proved to be low risk , Gleason Score 6 area, with a volume < 0.5 cc, which can be defined as «Insignificant» disease, with a negative predictive value (NPV) equal to 95-98%.

CONCLUSION

MRI/TRUS fusion biopsy shows a good correlation between "MRI index lesion" and definitive histopathological diagnosis on radical prostatectomy, in terms of dimensions, histological aggressiveness and highest Gleason Score of the pathology report.

CLINICAL RELEVANCE/APPLICATION

Among the new approaches to prostate biopsy, MR Imaging-Transrectal US Fusion has the potential to significantly increase the detection of csPCA.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSK10

Science Session with Keynote: Genitourinary (DECT)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: N228

CT GU

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Benjamin M. Yeh, MD, San Francisco, CA (*Moderator*) Research Grant, General Electric Company; Author with royalties, Oxford University Press; Shareholder, Nextrast, Inc; Research Grant, Koninklijike Philips NV; ;
Daniele Marin, MD, Durham, NC (*Moderator*) Research support, Siemens AG

Sub-Events

SSK10-01 Genitourinary Keynote Speaker: Vivid Material Separation at Multi-energy CT

Participants
Benjamin M. Yeh, MD, San Francisco, CA (*Presenter*) Research Grant, General Electric Company; Author with royalties, Oxford University Press; Shareholder, Nextrast, Inc; Research Grant, Koninklijike Philips NV; ;

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SSK10-02 A Probabilistic Approach to the Assessment of Renal Stone Mineral Composition Using Dual-Energy CT

Wednesday, Nov. 29 10:40AM - 10:50AM Room: N228

Participants
Andrea Ferrero, PhD, Rochester, MN (*Presenter*) Nothing to Disclose
Aeli Olson, St. Paul, MN (*Abstract Co-Author*) Nothing to Disclose
Jayse Weaver, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG

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PURPOSE

In dual-energy CT (DECT) a threshold in the ratio between the average CT number within the stone from a low kV and a high kV image is generally used to differentiate stone types. This approach has demonstrated near 100% accuracy in separating uric acid (UA) from non-uric acid (NUA) stones, however it has failed to yield acceptable performance in separating NUA subtypes, such as calcium oxalate and apatite stones. In this study, we investigated a probabilistic approach that replaced discrete classification of stone mineral composition with a likelihood estimation.

METHOD AND MATERIALS

Patients with a DECT scan of the abdomen followed by an ex vivo analysis of the removed stone were retrospectively evaluated with IRB approval. Of these, only the cases with pure stones (i.e. >90% purity) were included in the study. Each stone was segmented using automated in-house software, and histograms of the distribution of CT number ratios for each stone were generated. Each histogram was compared to simulated histograms for 5 mineral compositions: uric acid (UA), cystine (CYS), struvite (STR), calcium oxalate / brushite (COM/COD/BRU) and apatite (APA). The likelihood of each mineral composition was computed as the overlap of the area between each histogram. The most likely mineral composition was compared to the conventional, threshold based approach currently used in clinical practice. Accuracy for the two methods was computed as the percentage of patient cases whose stone was correctly classified, using the ex vivo composition analysis as reference.

RESULTS

228 patients were retrospectively identified. 112 patients that had a pure stone (as determined ex vivo through infrared spectroscopy) of at least 10 mm3 were included in the study. The threshold-based method correctly classified 70% of the stones, whereas the probabilistic method correctly classified 73% - 88% if the two most likely compositions were considered. Of note is that the average confidence for the correct cases was 65%, whereas it was below 50% for the incorrect cases.

CONCLUSION

A probabilistic approach that provides an estimation of composition likelihood has been shown to more accurately characterize renal stones compared to threshold-based methods.

CLINICAL RELEVANCE/APPLICATION

The proposed method would increase clinician confidence in the in vivo determination of urinary stone composition using DECT,

appropriately identifying cases where the assessment is more uncertain.

SSK10-03 Characterization of Small (<4 cm) Focal Renal Lesions: Diagnostic Accuracy of Spectral Analysis using Single-Phase Contrast-enhanced Dual-energy CT

Wednesday, Nov. 29 10:50AM - 11:00AM Room: N228

Participants
Bhavik N. Patel, MD,MBA, Stanford, CA (*Presenter*) Consultant, General Electric Company; Research support, General Electric Company
Kingshuk Choudhury, PhD, Durham, NC (*Abstract Co-Author*) Nothing to Disclose
Rendon C. Nelson, MD, Durham, NC (*Abstract Co-Author*) Research Consultant, General Electric Company; Research Consultant, Nemoto Kyorindo, Ltd; Consultant, VoxelMetrix, LLC; Co-owner, VoxelMetrix, LLC; Advisory Board, Bracco Group; Advisory Board, Guerbet, SA; Research grant, Nemoto Kyorindo, Ltd; Speaker Bureau, Bracco Group; Royalties, Wolters Kluwer nv
Daniele Marin, MD, Durham, NC (*Abstract Co-Author*) Research support, Siemens AG

PURPOSE

To determine whether single-phase contrast-enhanced dual-energy quantitative spectral analysis improves the accuracy of diagnosis for small (< 4.0 cm) renal lesions, compared to conventional single-energy attenuation measurements.

CONCLUSION

Single-phase contrast-enhanced dual-energy quantitative spectral analysis significantly improves the specificity for characterization of small (< 4.0 cm) renal lesions, compared to conventional single-energy attenuation measurements.

CLINICAL RELEVANCE/APPLICATION

Single-phase contrast enhanced dual energy quantitative spectral analysis can reliably characterize small renal lesions thereby reducing the need for additional subsequent dedicated renal lesion evaluation protocol imaging.

SSK10-04 Analysis of Dual Energy Spectral CT and Pathological Grading of Clear Cell Renal Cell Carcinoma

Wednesday, Nov. 29 11:00AM - 11:10AM Room: N228

Participants
Jinyan Wei, Lanzhou, China (*Presenter*) Nothing to Disclose
Junlin Zhou, Lanzhou, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To discuss the dual energy spectral CT imaging features of the pathological grading of clear cell renal cell carcinoma (ccRCC) and the correlation between spectral CT imaging features and pathology.

METHOD AND MATERIALS

We performed retrospective analyses of 62 patients with confirmed diagnosis of ccRCC. All patients underwent non-enhanced CT and dual-phase(cortex phase, CP and parenchyma phase, PP) contrast-enhanced CT with dual energy spectral mode. The subjects were pathologically divided into two groups: low-grade group (Fuhrman 1/2) and high-grade group (Fuhrman 3/4). The CT value of each lesion was measured on the monochromatic image of 70keV; the normalized iodine concentrations (NIC) and the slope of spectrum curve were calculated.The qualitative morphological parameters, including tumor shape, calcification, pseudocapsule, necrosis, and enhancement mode were compared between the two groups.

RESULTS

The CT value, NIC, and the mean slope of the low-grade group were higher than that of the high-grade group during CP(P=0.001, P=0.043, P<0.001, respectively). The CT did not differ significantly during PP(P=0.134); however, the NIC and mean slope varied considerably in the low grade than the high-grade group (P=0.048, P=0.017, respectively). The CT threshold value, NIC, and slope had high sensitivity and specificity in differentiating well-differentiated ccRCC from the poorly differentiated.The tumor shape, pseudocapsule, and necrosis differed significantly between the two groups (P<0.01).

CONCLUSION

Dual energy spectral CT with the quantitative analysis of iodine concentration and qualitative analysis of morphological characteristics increase the accuracy of diagnosing pathological grading of ccRCC.

CLINICAL RELEVANCE/APPLICATION

Clinnical relevance/application Dual energy spectral CT with the analysis of iodine concentration and the correlation between spectral CT imaging features and pathology may help increase the accuracy in differentiating the pathological grading of ccRCC

SSK10-05 Impact of Noise-Optimized Virtual Monoenergetic Dual-Energy Computed Tomography on Image Quality in Patients With Renal Cell Carcinoma

Wednesday, Nov. 29 11:10AM - 11:20AM Room: N228

Awards
Student Travel Stipend Award

Participants
Simon S. Martin, MD, Frankfurt, Germany (*Presenter*) Nothing to Disclose
Julian L. Wichmann, MD, Frankfurt, Germany (*Abstract Co-Author*) Speaker, General Electric Company; Speaker, Siemens AG

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PURPOSE

To perform a quantitative and qualitative image analysis of noise-optimized virtual monoenergetic images (VMI+) in patients with renal cell carcinoma (RCC) undergoing dual-energy computed tomography (DECT).

METHOD AND MATERIALS

Fifty-two patients (33 men; 61.5±13.6 years) with RCC underwent contrast-enhanced DECT during the corticomedullary and nephrogenic phase of renal enhancement. DECT datasets were reconstructed with standard linearly-blended (M_0.6) as well as traditional virtual monoenergetic (VMI) and VMI+ algorithms in 10-keV increments from 40 to 100 keV. Contrast-to-noise (CNR) and tumor-to-cortex ratios for corticomedullary- and nephrogenic-phase images were objectively measured. Subjective image quality and RCC delineation were evaluated by three radiologists.

RESULTS

Greatest CNR values were found for 40-keV VMI+ series in both corticomedullary- (8.9±4.9) and nephrogenic-phase (7.1±4.6) images and were significantly higher compared to all other reconstructions (P<0.001). Furthermore, tumor-to-cortex ratios were highest for 40-keV nephrogenic-phase VMI+ (2.1±3.5; P<=0.016), followed by 50-keV and 60-keV VMI+ (2.0±3.2 and 1.8±2.8, respectively). Qualitative image quality scored highest for 50-keV VMI+ series in corticomedullary-phase reconstructions and 60-keV in nephrogenic-phase reconstructions (P<=0.031). Highest scores for lesion delineation were assigned for 40-keV VMI+ reconstructions (P<=0.074).

CONCLUSION

Low-keV VMI+ reconstructions lead to improved image quality and lesion delineation of corticomedullary- and nephrogenic-phase DECT datasets in patients with RCC.

CLINICAL RELEVANCE/APPLICATION

In summary, our results demonstrate that the noise-optimized VMI+ algorithm substantially improves subjective and objective image quality of abdominal DECT examinations in patients with RCC compared to traditional VMI and standard linearly-blended images. Furthermore, low-keV VMI+ reconstructions have the potential to improve delineation of RCC lesions

SSK10-06 Dual-Source Single-Energy Multidetector CT Urography with Multiple Radiation Exposures within the Same Patient: Comparison of Full-Dose and Half-Dose Images Reconstructed with FBP and Half-Dose Images with SAFIRE

Wednesday, Nov. 29 11:20AM - 11:30AM Room: N228

Participants
See Hyung Kim, Daegu, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To prospectively compare image quality and lesion confidence of CTU images acquired at FBP with 100% radiation dose with those of CTU images simultaneously acquired at FBP and SAFIRE-3 with 100% and 50% radiation dose in patients with high risk for urothelial carcinomas.

METHOD AND MATERIALS

The institutional review board approved the study with written informed patient consent. 150 patients underwent CTU examinations using a dual-source single-energy scanner. Data from both tubes were reconstructed with FBP, and data from the primary tube only were reconstructed with SAFIRE. Seven radiologists subjectively assessed image quality and lesion confidence for 1200 total datasets. Nonparametric methods for cluster data were used to estimate the areas under the receiver operating characteristic curves (AUCs) for variance methods on the basis of a noninferiority margin of 0.05.

RESULTS

Mean AUCs of image quality in SAFIRE-3 at 25% radiation dose was significantly lower than those of FBP at 100% radiation dose (all P <0.05). The mean AUCs for the presence of lesion were 0.907 and 0.894 for FBP at 100% and 50% radiation doses, and 0.900 and 0.799 for SAFIRE-3 at 50% and 25% radiation doses. However, SAFIRE-3 at 25% radiation dose was significantly inferior to FBP at 100% radiation dose.

CONCLUSION

CTU images acquired at SAFIRE-3 with 25% radiation dose were inferior to those of FBP with 100% radiation dose for image quality and confidence for the presence of lesion, regardless of the radiologists' experience.

CLINICAL RELEVANCE/APPLICATION

CTU images acquired at SAFIRE-3 with 25% radiation dose were inferior to those of FBP with 100% radiation dose for image quality

and confidence for the presence of lesion, regardless of the radiologists' experience.

SSK10-07 The Application Value of Spectral CT Imaging in Distinguishing Renal Cell Carcinoma and Renal Angiomyolipomas

Wednesday, Nov. 29 11:30AM - 11:40AM Room: N228

Participants
Ma Guangming, MMed, Xianyang City, China (*Presenter*) Nothing to Disclose
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PURPOSE

To assess the value of dual-energy spectral CT imaging in differentiating renal cell carcinoma (RCC) from Renal Angiomyolipomas (RAML).

METHOD AND MATERIALS

53 patients with suspected renal tumors who underwent plain and contrast-enhanced CT in cortical phase and medulla phase with dual-energy Spectral imaging mode were retrospectively analyzed. There were 31 cases of RCC and 22 cases of RAML. Images were analyzed on an AW4.6 workstation with GSI Viewer software to measure the effective-Z and fat concentration for lesions with the plain scan, CT values in 70keV images and iodine concentration (IC) in the cortical and medulla phases for lesions. The iodine concentration was normalized to that of the aorta to obtain normalized iodine concentration (NIC), and the difference of NIC between medulla and cortical phases was calculated. The above quantitative parameters from lesions were compared using independent sample t test, and ROC analysis was used to evaluate their diagnosis efficiency in differentiating RCC from RAML.

RESULTS

The Effective-Z, fat concentration, NIC in cortical phase, medulla phase, NIC difference, CT value in cortical phase and medulla phase for RCC were 7.60±0.13, -143.03±32.75g/L, 0.64±0.13, 0.49±0.15, 0.14±0.18, 116.53±14.29HU, 94.8±12.34HU, respectively; while the corresponding values for RAML were 7.74±0.11, -103.24±9.84 g/L, 0.50±0.88, 0.58±0.12, -0.08±0.13, 96.47±18.46HU, 105.58±14.14HU, respectively. The differences for these parameters between the two lesion types were statistically significant (all $p<0.05$). Using the threshold value of -112.8g/L for the fat concentration in ROC analysis, one would obtain a sensitivity of 90.9% and specificity of 77.4% for differentiating RCC from RAML and the area under the curve was 0.89.

CONCLUSION

The parameters obtained in dual-energy spectral CT scans demonstrated appreciable clinical values for differentiating RCC from RAML, with the fat concentration providing the highest diagnostic performance.

CLINICAL RELEVANCE/APPLICATION

Dual-energy spectral CT is a promising method in differentiate RCC from RAML.

SSK10-08 Does Dual Energy CT Have the Ability to Differentiate Benign vs Malignant Ovarian Tumors?

Wednesday, Nov. 29 11:40AM - 11:50AM Room: N228

Awards
Student Travel Stipend Award

Participants
Steven W. Zheng, MD, Houston, TX (*Presenter*) Nothing to Disclose
Dhakshina M. Ganeshan, MBBS, FRCR, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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Wei Wei, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To assess the ability of dual energy CT (DECT) to distinguish benign from malignant ovarian tumors (OT).

METHOD AND MATERIALS

Following approval of the institutional-review-board, institutional database was mined for treatment naïve patients who underwent primary cytoreduction for OT. 35 patients were included in the study. 17 patients had high grade, 8 had low grade, and 10 had benign tumors. Age, gender pathological diagnosis following surgical resection and tumor grade was documented. Advanced processing using the Advantage Work (AW) station was performed on the preoperative dual energy CT scan. ROIs were drawn on the ovarian mass on the AW. Pixel level data of the tumor was recorded for different energy levels 50 keV, 70 keV and 120 keV. The effective-Z (atomic number) amount of water and iodine present in the ovarian mass was recorded. Kruskal;Wallis test was used to compare the differences between three types of OT. All tests were two;sided and $p < 0.05$ were considered statistically significant.

RESULTS

Patients with high grade OTs were older than those with the low grade and the benign OTs ($p = 0.02$). High grade OT had higher

Hounsfield values than low grade and benign OT at 50 keV (p = 0.001), 70 keV (p = 0.0006), 120 keV (p = 0.0009), and higher amount of water g/cm3 (p < 0.005). Benign OT had significantly lower atomic number (p = 0.002) and amount of iodine g/cm3 (p = 0.002) compared to malignant OT.

CONCLUSION

Dual energy CT has the potential to distinguish between high grade, low grade and benign ovarian tumors. Given the small sample size, future trials may be helpful in confirming our findings.

CLINICAL RELEVANCE/APPLICATION

DECT has the potential to differentiate between benign and malignant tumors and may be helpful in avoiding unneccessary surgery.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Priya R. Bhosale, MD - 2012 Honored Educator

SSK10-09 Dual Layer Spectral CT: Non-Inferiority Assessment Compared To Dual Source Dual Energy CT in Discriminating Uric Acid from Non-Uric Acid Stones in a Phantom Model

Wednesday, Nov. 29 11:50AM - 12:00PM Room: N228

Participants
Lakshmi Ananthakrishnan, MD, Dallas, TX (*Presenter*) Nothing to Disclose
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Yin Xi, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose
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Suhny Abbara, MD, Dallas, TX (*Abstract Co-Author*) Author, Reed Elsevier; Editor, Reed Elsevier; Institutional research agreement, Koninklijke Philips NV; Institutional research agreement, Siemens AG
Matthew A. Lewis, PhD, Dallas, TX (*Abstract Co-Author*) Research collaborations, CMR Naviscan Corporation and QT Ultrasound Labs
Robert E. Lenkinski, PhD, Dallas, TX (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV Research Consultant, Aspect Imaging
Jodi A. Antonelli, MD, Dallas, TX (*Abstract Co-Author*) Scientific Advisory Board, Boston Scientific Corporation
Margaret S. Pearle, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose
Elysha M. Kolitz, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess non-inferiority of novel dual layer spectral detector CT (SDCT) technology in comparison to dual source dual energy CT (dsDECT) in discriminating between uric acid (UA) and non-UA stones

METHOD AND MATERIALS

In this phantom study, 57 surgically extracted urinary calculi were placed in individual tubes within a cylindrical phantom in a water bath. CT images were obtained at 1 mm slice thickness and 0.5 mm intervals on a prototype SDCT scanner (IQon, Philips Healthcare), and second and third generation dsDECT scanners (Somatom Flash and Force, Siemens Healthcare) under matched scan parameters. For SDCT data, effective Z images and virtual monoenergetic images (40, 62, 92, 100, and 200 keV) were created. For SDCT data, 3D growing region segmentation tool using custom pyOsirix software was used to segment each stone on the various reconstructions for pixel by pixel analysis. Median virtual monoenergetic ratios (VMR) of 40/200, 62/92, and 62/100 (chosen as VMR theoretically yielding best spectral separation, equivalent of 100/140Sn, and 100/150Sn kVp ratios used in dsDECT) and effective Z (Zeff) values for each stone were recorded. For dsDECT data, dual energy ratio (DER) for each stone was recorded from vendor specific post-processing software (Syngo Via) using the Kidney Stones Application. The clinical reference standard of x-ray diffraction analysis was used to assess non-inferiority. Pearson's correlation coefficient was calculated to assess correlation between the 3 VMRs and 2 DERs.

RESULTS

6 pure UA, 47 pure calcium based, 1 pure cystine, and 3 mixed struvite stones were scanned. All pure UA stones were correctly separated from non-UA stones using SDCT and dsDECT. For UA stones, median VMR was 0.95-0.99, Zeff 7.2, DER 1.00-1.02. For non-UA stones, median VMR was 1.65-4.1, Zeff 10.76, and DER 1.54-1.69. VMR ratio 40/200 provided the greatest difference between UA and non-UA stones. There was excellent correlation between the 3 VMRs and DERs (Pearson's correlation coefficient 0.89-0.94, p<.0001). More variability was noted using Zeff.

CONCLUSION

SDCT spectral reconstructions demonstrate similar performance to dsDECT in discriminating UA from non-UA stones in a phantom model.

CLINICAL RELEVANCE/APPLICATION

Uric acid stones may be differentiated from non uric acid stones using novel dual layer spectral detector CT technology in a phantom model.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality

educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Suhny Abbara, MD - 2014 Honored EducatorSuhny Abbara, MD - 2017 Honored Educator

SSK11

Science Session with Keynote: Health Service, Policy and Research (Education)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S105AB

HP ED

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Marc H. Willis, DO, Houston, TX (*Moderator*) Nothing to Disclose
Leif Jensen, MD,MPH, Salt Lake City, UT (*Moderator*) Nothing to Disclose

Sub-Events

SSK11-01 In the Era of Tumor Genotyping, Molecular Imaging and Immunotherapy, Should Dedicated Cancer-Imaging Training Be Added to the Radiology Residency Curriculum?

Awards
Student Travel Stipend Award

Participants
Shanna A. Matalon, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

Cancer treatment has recently undergone a dramatic shift toward personalized care, with new therapies significantly prolonging life, often in the setting of advanced disease. The imaging of treatment response and toxicity has dramatically changed with the advent of molecular targeted agents and immune modulating drugs. Despite these changes, there are currently no specific guidelines regarding the teaching of cancer-imaging to radiology residents. This study surveyed radiology chief residents (CRs) and program directors (PDs) to determine the current state of cancer-imaging teaching in residency.

METHOD AND MATERIALS

An IRB-exempt survey was provided to CRs and PDs at the Association of University Radiologists (AUR) meeting in 2014. Survey results were summarized using frequency and percentages. Chi-square tests and Fisher's exact test were used for statistical analysis.

RESULTS

102 CRs and 64 PDs responded. Most respondents were from university-based residency programs (80% of CRs, 70% of PDs) and most reported program size >30 residents (64% of CRs, 44% of PDs). Most CRs and PDs report incorporation of cancer imaging into residency education by body part (70% and 75%, respectively), with very few having a dedicated cancer-imaging block (6% and 8%, respectively). While most CRs report 6 or more cancer-imaging lectures annually (69%), fewer than half have dedicated lectures on treatment response, side effects and genomics (43%, 37% and 34%, respectively). Just over half of CRs and PDs would like a dedicated, standardized cancer-imaging curriculum added to the ABR residency curriculum guidelines (52% and 57%, respectively). CRs that had lectures on treatment response were significantly more likely to want added curricula (P=.0053).

CONCLUSION

Despite radiologists' integral role in cancer care, most residencies do not currently incorporate dedicated cancer-imaging teaching blocks, with curricula lacking in topics such as cancer treatment response, side effects and genomics.

CLINICAL RELEVANCE/APPLICATION

Despite dramatic advances in cancer treatment, cancer-imaging education may be lagging behind; radiology residencies must adapt to include dedicated cancer-imaging teaching, in order to ensure imagers remain essential members of the oncologic team.

SSK11-02 Medicolegal Issues in Radiology Training

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S105AB

Participants
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PURPOSE

Radiologists comprise approximately 3.6% of US physicians while ranked 6th in medicolegal claims. Studies suggest that by age of 60, 50% of radiologists will be sued at least once. Given this inevitability, it is surprising how little attention is paid to teaching of medicolegal and malpractice issues during training and practice. Most trainees emerge from residency with only a vague notion of the medicolegal issues inherent in radiology, and it is hypothesized that most radiologists would benefit from additional training on these topics.

METHOD AND MATERIALS

All the radiology attending, trainees and alumni in our tertiary care 1500-bed teaching hospital were surveyed via an electronic questionnaire. Respondents were surveyed on their overall knowledge of job-related medicolegal issues and willingness to receive additional education. The survey also included two real life medicolegal scenarios and the radiologists were asked to choose the most likely result.

RESULTS

A 9-item questionnaire was sent to total of 332 trainees, attending and alumni. There were 104 responses constituting a response rate of 31% (104/332) from 60% (62/104) academic and 40%(42/104) private practice radiologists, F:M 29:75. Only 36% of the respondents were aware that by age of 60, half of them would be involved in at least one lawsuit. All knew the most common causes of malpractice claims in the United States, however, only one-third were aware of available resources offered by ACR. 80% never received training on medicolegal issues during residency and 97% believed that additional education would be useful; 87% showed willingness to attend post-residency medicolegal CME courses. All the residents believed that medicolegal lectures should be included in the didactics.

CONCLUSION

There is a dearth of knowledge among radiologists on job-related medicolegal topics, and radiologists are willing to acquire additional training in the form of targeted didactic sessions for trainees or CME for the graduates. This survey suggests that, at a minimum, incorporating additional medicolegal topics into the non-interpretive skills curriculum of residents would be well received.

CLINICAL RELEVANCE/APPLICATION

As medicolegal issues are numerous in radiology this topic should be of interest to all radiologists in active practice.

SSK11-03 Health Service, Policy and Research Keynote Speaker: Understanding the Cost of Care

Wednesday, Nov. 29 10:50AM - 11:00AM Room: S105AB

Participants
Yoshimi Anzai, MD, Salt Lake City, UT (*Presenter*) Nothing to Disclose

SSK11-04 Global Lecture Sharing from United States Radiology Residency Programs: A Vital Branch of Improving Radiology Outreach

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S105AB

Participants
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PURPOSE

Education is an important component of any successful and sustainable radiology program, which warrants continuous and methodical improvement. However, there is often a lack of structured radiology training in countries with limited resources. In addition to clinical teaching, which can only be provided in person, sharing of educational material is feasible nearly everywhere around the world. While utilizing publicly accessible materials from the internet is one option to supplement learning, we hypothesized that participating remotely in lectures provided by a well-established training program with a more structured didactic system may provide additional benefits to all, especially as outreach to less resourced establishments within developing countries. The purpose of this study was to assess whether live streaming of educational resident lectures to a partner program in a developing country can have an impact on radiology training and patient care.

RESULTS

The pre-survey demonstrated that 80% of the residents stated they currently have educational lectures once a week or less. 90% believe that live-streamed lectures could be useful for their daily work and case spectrum, 65% percent believe there will be an immediate impact on local patient care, while 35% percent believe there will be no immediate impact, but potential long-term impact. Areas of particular interest included Musculoskeletal radiology, Neuroradiology, Chest Imaging, and Breast Imaging. After implementation of the lecture-sharing program, preliminary feedback from 13 residents demonstrated that 100% of residents thought the lectures have assisted them in learning radiology and 53% of them felt that they were exposed to new material.

CONCLUSION

Lecture sharing as an initiative to improve education in resource limited settings has substantial potential to impact radiology training programs and has proven beneficial during this outreach project. The future goal is to stream at least one lecture per week use follow-up surveys to continually assess any improvement in learning habits, local didactic culture and eventually patient care. As the project progresses, the frequency of streamed lectures will be increased and the program will be expanded to other partner-

institutions in other developing countries. Long-term impact on examination performance will be studied annually to assess any change in overall performance of trainees, which could be attributed to lecture sharing. Ultimately, maintaining a robust relationship is the most important goal, which would facilitate residents' access to a stored lecture database and also facilitate developing direct resident exchange programs between countries.

METHODS

Twenty residents from a radiology residency program in the country of Jamaica, were surveyed about their interests in participating in streamed lectures from our institution. Survey questions included gathering information about their current learning tools and resources, their current lecture system and logistics of participating in lectures remotely. Members of our institutional faculty were also surveyed about willingness to participate and feasibility of this concept. The current lecture infrastructure was expanded to include remote communication capabilities, which included using a web conferencing software platform. A preset link was generated for access to the sessions and this was distributed in advance to the residents after they signed applicable waivers. After implementation of the project, residents were surveyed to assess impression of the lecture system.

PDF UPLOAD

https://abstract.rsna.org/uploads/2017/17017751/17017751_mxxx.pdf

SSK11-05 Factors that Influence the Choice of Radiology as a Specialty and Analysis of Factor Relationships with Job and Career Satisfaction During Residency

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S105AB

Awards
Student Travel Stipend Award

Participants
Jeffrey P. Guenette, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

Improve radiology recruitment efforts by identifying what factors influence medical students' choice of radiology and what factors correlate with job and career satisfaction.

METHOD AND MATERIALS

An IRB-exempted online survey was distributed to United States radiology residents by email between December 7, 2016 and March 31, 2017. Respondents identified what aspect of radiology was most appealing during medical school and what experience was most influential in choosing radiology. Respondents also completed visual analog scale measures of career choice satisfaction and current job satisfaction. Descriptive statistics were performed to evaluate relative factor importance. Analysis of variance with post hoc Tukey honest significance difference test was performed to compare career and job satisfaction scores across factors.

RESULTS

A total of 488 radiology residents (age 30.8 ± 3.2 years; 358 male, 129 female, 1 non-responder; 144 PGY1, 123 PGY2, 103 PGY3, 118 PGY4) responded. Respondents were most drawn to the intellectual component (n=187, 38%), imaging component (n=100, 20%), procedure component (n=96, 20%), and potential lifestyle (n=69, 14%) of radiology. Individuals were most influenced by radiology clerkship reading room shadowing (n=143, 29%), radiologist mentor (n=98, 20%), non-radiology clerkship imaging exposure (n=77, 16%), and radiology clerkship interventions exposure (n=75, 15%). Residents who chose radiology primarily for potential lifestyle recorded less career satisfaction and less job satisfaction than residents who chose radiology for its intellectual (p=0.00005 and 0.0004) and imaging (p=0.00002 and 0.0003) components. There was no significant relationship of influential experiences with career or job satisfaction.

CONCLUSION

Effective recruitment of medical students into radiology may best be achieved by radiology clerkships that emphasize the intellectual and imaging components of radiology through reading room shadowing and exposure to interventions. Those who choose radiology for potential lifestyle appear less likely to have job and career satisfaction, at least during residency.

CLINICAL RELEVANCE/APPLICATION

Optimal recruitment of medical students into radiology may be achievable through radiology clerkships that emphasize the intellectual and imaging components of radiology.

SSK11-06 Development, Implementation, and Evaluation of a Medical Student Radiology Elective

Wednesday, Nov. 29 11:20AM - 11:30AM Room: S105AB

Participants
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PURPOSE

To re-structure a medical student Radiology elective based on the results of a needs assessment and to prospectively evaluate implemented interventions.

METHOD AND MATERIALS

An online retrospective survey was sent to medical students who completed a Radiology elective during the 2015 calendar year. Students were asked to evaluate current and potential elective activities using dichotomous, ranking, and 5-point Likert scale questions (5=excellent, 4=very good, 3=good, 2=fair, 1=poor). The Salant-Dillman survey protocol was used to maximize response rate. Based on these results, three new interventions were piloted: a more structured schedule, bi-weekly resident-led medical student rounds and the creation of a medical student case bank. These changes were implemented from July 1- December 31, 2016 and were prospectively assessed using the same methodology as the needs assessment. Responses were analyzed using descriptive statistics and t-tests.

RESULTS

Response rate for both the needs assessment and prospective survey was good (62% and 90%). In the needs assessment, mean score for overall elective experience was 3.4/5 (SD=1.08) and self-rated knowledge gained was 3.4/5 (SD=0.99). The highest rated educational activities were: working with residents (mean=4.1/5, SD=1.24) and attending resident rounds/self-study time (mean=3.6/5, SD=1.11/1.26). Prospective evaluation of the three interventions showed an increased score for overall elective experience of 4.24/5 (SD=0.90, p=0.022) and for perceived knowledge gained (mean=3.76/5, SD=0.83, p=0.11). The resident-led rounds and case bank were the highest rated activities students encountered in the new elective with scores of 4.87/5 (SD=0.35) and 4.67/5 (SD=0.49) respectively.

CONCLUSION

This study describes the successful re-structuring of a medical student Radiology elective with improved scores in student satisfaction and knowledge gained.

CLINICAL RELEVANCE/APPLICATION

These results are important to medical educators and may facilitate the creation of higher quality electives for medical students.

SSK11-07 Resident Perception of the Use of Peer Teachers for Hands-On Ultrasound Training

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S105AB

Participants
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PURPOSE

To determine resident perceptions of the use of peer teachers for hands-on radiology resident education.

METHOD AND MATERIALS

Hands-on musculoskeletal and abdominal ultrasound scanning workshops were designed for radiology residents. Prior to the workshops several senior residents received three hours of training, and then served as instructors ("peer teachers") during the workshops. During the workshops, demonstrations were performed by an attending radiologist or senior sonographer, followed by small-group hands-on scanning led by the peer teachers. Following the workshops resident participants and peer teachers completed surveys with 5-point Likert scale statements regarding their experience. Median scores and interquartile ranges (IQR, 25-75%) were calculated.

RESULTS

40 residents from all years of training and 9 senior resident peer teachers participated in 6 workshops. Participants thought that peer teachers were effective (median score 5, IQR 4-5), would like to be taught by peer teachers again (5, 4-5) and were interested in serving as peer teachers (4, 3-5). Peer teachers highly rated the overall experience (5, 5-5), were interested in serving as peer teachers again (5, 5-5), and found peer teaching enjoyable (5, 5-5). Peer teachers felt comfortable with the material (4, 4-5) and were able to answer most questions posed to them (4, 3-5). Peer teaching resulted in increased understanding of ultrasound technique and anatomy (5, 5-5). 78% of peer teachers thought that 3 hours of training was sufficient, while all thought that group size (3-4 residents per small group) was appropriate.

CONCLUSION

Use of peer teachers for hands-on ultrasound training is viewed extremely positively by resident participants and peer teachers. Residents found peer teaching educational, enjoyable and highly rated the overall experience. Both resident participants and peer teachers were interested in participating in peer teaching again. A ratio of 1 peer teacher for 3-4 trainees is appropriate for effectively teaching ultrasound scanning technique, and approximately 3 hours of peer teacher training is required.

CLINICAL RELEVANCE/APPLICATION

Peer teaching is viewed extremely positively by residents and can play a role in hands-on training of radiology residents.

SSK11-08 Procedural Training in Radiology Residency: Variability in the Use of Simulation

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S105AB

Participants
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PURPOSE

Increased attention to quality and safety has cast doubt on the classic "see one, do one" model of procedural training. Many have proposed simulation training as an additional teaching tool in procedural training. This study surveyed radiology residents to determine if and how simulation-based training is being utilized during residency.

METHOD AND MATERIALS

An IRB-exempt online survey was distributed to current radiology residents in the United States by e-mail. Survey results were summarized using frequency and percentages. Chi-square tests were used for statistical analysis where appropriate.

RESULTS

353 residents completed the survey. Thirty-seven percent (n=129/353) of residents have not participated in procedure simulation (37%, n=129/353). Of the residents who have used simulation, most did not do so until after having already performed procedures on patients (59%, n=132/223). Vascular/interventional (VIR) radiology is the most common subspecialty in which residents get hands-on exposure to procedures (96%, n=336/352), but only 26% (n=57/222) reported procedural simulation use in VIR. Simulation was most commonly utilized by breast and abdominal divisions (n=97/222, 44%, and n=95/222, 42%, respectively). The presence of a dedicated simulation center was reported by over half of residents (56%, n=196/353) and was associated with prior simulation experience (P=.007). Simulation training was associated with higher comfort levels in performing procedures (P<.001).

CONCLUSION

Although procedural simulation training is associated with higher comfort levels in performing procedures, there is variable use in radiology resident training and its use may not be currently optimized. Results suggest the need to increase procedural simulation use throughout US residencies, including earlier introduction to simulation during residency, particularly within the vascular/interventional division.

CLINICAL RELEVANCE/APPLICATION

Simulation training is associated with higher resident comfort levels in performing procedures, but its use is variable in resident training and increased use may benefit both resident training and ultimately, patient care.

SSK11-09 Integrating Simulated Clinical Decision Support at the Point-of-Order into Physician Assistant Students' Radiology Curriculum

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S105AB

Participants
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PURPOSE

Improving appropriateness of imaging is a national focus, including imaging requested by advanced practice providers (Hughes et al, JAMA Intern Med 2015;175(1):101-107). Given our experience in this arena, we engaged leadership from our physician assistant program to innovate the radiology education curriculum. We introduced a cutting-edge clinical tool (ACR Select) through an education simulation portal. In an era of evolving decision support for medical providers, this simulation portal exposes future ordering providers to evidence-based medicine and clinical decision support.

METHOD AND MATERIALS

We utilized an education portal integrated with ACRSelect to allow learners to simulate ordering imaging studies with clinical decision support. Learners received instant feedback during their simulation. Our program utilized a hybrid classroom experience. The learners met with key members of our radiology team in a traditional classroom before and after the simulation education. Assessment was via a pre/post-assessment a qualitative survey.

RESULTS

In 2015, sixteen students completed both tests, and on average, showed a gain of 11% from one test to the next. A paired t-test between students' pre- and posttest scores was statistically significant - $t(15)=4.664$, $p<0.001$, with a large effect size (Cohen's $d = 1.166$). In 2016, the module cases were updated and refined. The test items were accordingly updated. Thus, comparisons cannot be made directly between the two groups. However, similar to the 2015 cohort, the 2016 cohort, also had about an 11% increase from pre- to posttest, which was a statistically significant average content knowledge gain $t(17)=3.4436$, $p=0.003$, with a

large effect size (Cohen's d = 0.812).

CONCLUSION

The role of advanced practice providers is expected to expand within our evolving health care system. Their radiology curricula need to empower these future providers to request the "right test at the right time". Evidence-based, simulated ordering of imaging exams with integrated clinical decision support is a promising resource. This web-based platform is easily scalable which enhances the potential to have a broad and meaningful impact on medical education.

CLINICAL RELEVANCE/APPLICATION

Given the challenges of our current health care situation and national trends in medicine, it is imperative that we find more efficient and effective mechanisms to better educate and prepare medical providers for the future.

SSK12

Molecular Imaging (Infection and Inflammation)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S504CD

CT MR MI NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Kathryn A. Morton, MD, Salt Lake City, UT (*Moderator*) Nothing to Disclose
Vikas Kundra, MD, PhD, Houston, TX (*Moderator*) Institutional license agreement, Introgen Therapeutics, Inc; Research Grant, General Electric Company

Sub-Events

SSK12-01 Fluorescence Molecular Imaging of Cathepsin Activity as a Novel Biomarker for Giant Cell Arteritis

Participants
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PURPOSE

The aim of this study was to investigate whether cathepsin activity can be utilized as a novel biomarker for presence and inflammatory status of giant cell arteritis (GCA).

METHOD AND MATERIALS

Biopsy specimen of the temporal artery from patients (n=91, average age: 74 years) with a suspected giant cell arteritis were partially subjected to immunohistological analyses of the expression of Cathepsin K, L and B. The enzymatic activity of the specimen was assessed in n=61 cases with a fluorometric essay sensitive to cathepsin K. Ex vivo fluorescence imaging using a pan-cathepsin activatable fluorescent imaging agent was performed in n=45 temporal artery biopsy specimen and in n=13 segments of the internal thoracic artery from non-vasculitis patients (control group) undergoing cardiac bypass surgery. Cathepsin-based methods were compared to standard clinical diagnostics, serology, presurgical MRI and routine histology.

RESULTS

The clinical reference diagnosis revealed n=18 negative cases, n=45 positive cases and n=28 cases with inconclusive results. Immunohistochemistry (Figure) showed significantly increased ($p<0.001$) expression of cathepsins B, K and L in patients diagnosed with GCA versus negative diagnoses. GCA positive biopsy specimen also had significantly increased cathepsin activity compared to negative biopsy specimen ($p<0.01$) and compared to control arteries from bypass surgery ($p<0.05$) as determined by ex vivo fluorescent imaging. Supporting a pathogenic role for cathepsin K, tissue lysates showed increased Cathepsin K enzymatic activity ($p<0.001$). The ex vivo fluorescent signal moderately but significantly correlated with cathepsin K activity ($R^2=0.63$, $p<0.001$), and strongly with the histological scores of all cathepsin stainings (Cathepsin B: $R^2=0.74$; Cathepsin K: $R^2=0.72$; Cathepsin L: $R^2=0.76$; $p<0.001$).

CONCLUSION

These in vitro findings demonstrate that cathepsins can be utilized as an immunohistological and imaging biomarker for the diagnosis of GCA.

CLINICAL RELEVANCE/APPLICATION

Cathepsins possibly offer a translational approach towards in vivo fluorescent imaging for the non-surgical diagnosis of GCA.

SSK12-02 Comparison of Different Semi-quantitative Approaches for the Diagnosis of Graft Infection after Thoracic or Abdominal Aortic Repair Using [F-18]-FDG PET/CT

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S504CD

Participants
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PURPOSE

The aim of this study was the evaluation and comparison of different semiquantitative parameters for the diagnosis of graft infection after thoracic or abdominal aortic repair applying [18F]fluorodeoxyglucose (FDG) positron emission tomography (PET)/computed tomography (CT).

METHOD AND MATERIALS

50 patients who underwent [18F]-FDG PET/CT for suspected aortic graft infection were retrospectively analysed. Besides, 13 oncological patients with aortic repair but without graft infection were included in the analysis. Maximum standardized uptake values (SUVmax) were obtained for all patients and different graft to background ratios were calculated. The diagnostic accuracy of SUVmax and different target-to-background ratios (TBRs) was assessed by receiver-operating-characteristic (ROC) analysis. Overall, 8 different background regions were defined and analysed (blood pool activity within the left cardiac ventricle, 4 different aortic segments, the vena cava and the pulmonary trunk as well as FDG wall uptake in non inflammatory aortic segments). A combination of clinical follow-up, imaging (including PET/CT) and/or microbiological/histopathological results, if available, served as the standard of reference for the final diagnosis.

RESULTS

28 infected and 35 uninfected grafts were identified. SUVmax was the most powerful predictor for the diagnosis of graft infection according to the ROC analysis (area under the curve: 0.978, CI: 0.904-0.999). ROC analysis suggested an SUVmax cut off value of >4.48 to differentiate between infected and non-infected grafts ($p<0.0001$). Notably, there was no substantial difference between SUVmax and other semiquantitative approaches (TBR) according to the area under the curve.

CONCLUSION

Semiquantitative approaches and in particular SUVmax provide a good reference to assess graft infection after thoracic or abdominal aortic repair and may increase the diagnostic accuracy of [18F]-FDG-PET/CT in the setting of suspected graft infection.

CLINICAL RELEVANCE/APPLICATION

[18F]-FDG-PET/CT is increasingly used in the setting of suspected aortic graft infection. However, data is limited with respect to different semiquantitative approaches for the diagnosis of graft infection. According to our results, SUV max showed the best performance to differentiate between infected and non-infected grafts and may increase the diagnostic accuracy of [18F]-FDG-PET/CT.

SSK12-03 Ultrasound-detectable O2 Microbubbles Generated from Catalase-Containing Silica Nanoshells (CSNs) in Determining Infected from Non-infected Fluid Collections in Humans

Wednesday, Nov. 29 10:50AM - 11:00AM Room: S504CD

Participants
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PURPOSE

Elevated levels of hydrogen peroxide (H2O2) play a key role in neutrophil oxidative defense against infection. Catalase-containing silica nanoshells (CSNs) are novel nanoparticles that generate oxygen microbubbles (O2 MBs) in the presence of elevated levels of H2O2. We aim to determine whether ultrasound detectable O2 MBs produced by CSNs can distinguish infected from non-infected fluid collections drained from patients.

METHOD AND MATERIALS

During this HIPAA-compliant, IRB-approved study, 52 human fluid samples were collected from clinically-required, image-guided percutaneous drainage procedures. Each sample was placed in a 3 mL transfer pipette imbedded in a tissue mimicking agarose/corn starch holder. Both the holder and the face of a Siemens Sequoia 512; 15L8-S linear transducer were submerged and mechanically held in a 37 °C water bath. CSNs were added to the fluid samples while imaging in real-time using the CPS microbubble-only imaging technique. Production of detectable MBs was graded subjectively as negative (not infected), or mild, moderate, or marked (infected) by a single observer blinded to all clinical data. The truth standard was culture results performed by the Microbiology laboratory. Performance characteristics including ROC curves were calculated.

RESULTS

Presence of MB formation to distinguish infected from non-infected fluids was 84% sensitive and 72% specific, and offered positive and negative predictive values of 64% and 89%, respectively. The area under the ROC curve (AUC) was 0.79. All nine false positive cases were peritoneal fluid collections, which could be indicative oxidative stress rather than infection.

CONCLUSION

The presence of elevated H2O2 recognized by MB formation in the presence of CSNs is sensitive in distinguishing infected from non-infected fluids with a relatively high negative predictive value. CSNs may offer a novel point of care method at the time of

percutaneous drainage, potentially obviating placement of drains in otherwise sterile collections to minimize risk of colonization and secondary infection.

CLINICAL RELEVANCE/APPLICATION

CSN technology can be administered through a needle or potentially incorporated on existing needles/catheters, functioning as a point of care device during percutaneous drainage or aspiration.

SSK12-04 Utility of F18 FDG PET/CT in Evaluation of Pyrexia of Unknown Origin

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S504CD

Participants
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Nikhil Kamat, MD, Thane, India (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Pyrexia of Unknown Origin (PUO) often poses diagnostic challenge. Timely diagnosis helps in guiding appropriate treatment. The aim of this retrospective study was to asses the contribution of Fluorine-18 Fluorodeoxyglucose (18F-FDG) Positron Emission Tomography /Computed Tomography (PET/CT) in the diagnostic evaluation of PUO.

METHOD AND MATERIALS

46 consecutive patients of PUO (23 men and 23 females, Age Range: 5 to 75 years) referred for 18F-FDG PET/CT between December 2015 to March 2017 were evaluated. Biopsy confirmation was available in 12 patients. Remaining patients underwent biochemical, microbiological, clinical and imaging follow up.

RESULTS

FDG PET/CT identified hypermetabolic foci in 42 patients (91.30%). Out of these, 14/42 patients revealed non-specific FDG uptake which did not contribute to final diagnosis. No abnormal focal FDG uptake was seen in 4 patients. No pathological disease was diagnosed in these 18 patients on subsequent work-up and were afebrile on follow up. Among the definite positive scans in 66.67% patients(28/42), various etiologies identified were as follows: A) Infectious etiology (n=15) including tuberculous lymphadenitis(7/15),septic arthritis (1/15), otitis media (1/15), acute hepatitis (1/15), infected prosthesis (2/15), spondylodiskitis (2/15), gluteal pyogenic abscess(1/15); B) Inflammatory etiology (n=10) such as Interstitial lung disease (2/10), Inflammatory mesenteric lymphadenopathy (2/10), Synovitis (2/10), Polymyositis and Dermatomyositis (2/10)Vasculitis (2/10); C) Malignancy (n=3) in colon carcinoma, adrenocortical carcinoma of lung, liver metastases from unknown primary.

CONCLUSION

18F-FDG PET/CT has a useful role in identification of pathological focus in PUO. Negative FDG PET/CT scan reliably rules out focal etiologies for PUO. Further prospective studies are warranted for confirmation.

CLINICAL RELEVANCE/APPLICATION

18F-FDG PET/CT has higher sensitivity to identify occult pathologies in PUO.

SSK12-05 Ultra-small Superparamagnetic Iron Oxide Nanoparticle as a Surrogate Marker of Aortic Wall Inflammation Following Radiation Therapy for Pancreatic Cancer

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S504CD

Participants
Sandeep S. Hedgire, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

Radiation therapy for cancer can lead to atherosclerosis by inducing inflammatory changes in the vascular wall. Though atherosclerotic changes can be seen with CT and MRI techniques, it is difficult to quantitatively measure inflammation on CT and MR imaging studies. The purpose of this study was to assess the use of ferumoxytol- an ultrasmall superparamagnetic iron oxide nanoparticle, as a surrogate marker of vessel wall inflammation secondary to radiation therapy in pancreatic cancer patients in comparison with healthy volunteers.

METHOD AND MATERIALS

MRI of upper abdomen (T1, T2, multi-echo T2*-weighted imaging) was performed on 3T magnet before and 48 hours after intravenous administration of ferumoxytol in pancreatic cancer patients who underwent radiation therapy (n=8) and healthy volunteers (n=8). R2* value was obtained by drawing regions of interest (ROIs) outlining the aortic wall directly on the T2* medic image and subsequently transposed to the R2* image using Amira software (Version 5.3.2, FEI, Bordeaux, France). The change in R2* values was analyzed by student's t-test.

RESULTS

The average change in R2* value of the pancreatic cancer patients was determined to be 216.18 1/ms. The average change R2*

value of the control patients was determined to be 54.67 1/ms. This indicates that the pancreatic cancer patients following radiation therapy had a greater uptake of ferumoxytol (p=0.0082) in their aortic wall.

CONCLUSION

Ferumoxytol can offer a non invasive, quantitative assessment of vascular inflammation following radiation therapy in cancer patients.

CLINICAL RELEVANCE/APPLICATION

Radiation therapy induced atherosclerosis could potentially be diagnosed earlier on due to its inflammatory nature. Ferumoxytol enhanced MRI offers a novel, radiation-free imaging marker of inflammation, would augment risk stratification, inform therapeutic decisions, and allow safe, robust, and quantitative monitoring of therapy-mediated changes.

SSK12-06 Anti-Inflammatory Therapeutic Effects in Swine Acute Ileitis: Longitudinal Monitoring with Ultrasound Molecular Imaging

Wednesday, Nov. 29 11:20AM - 11:30AM Room: S504CD

Participants
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PURPOSE

Ultrasound molecular imaging (USMI) using P- and E-selectin targeted microbubbles (MBselectin) has been shown to accurately quantify inflammation at molecular level in rodent and swine models of inflammatory bowel disease (IBD). This study aimed to assess whether USMI allows longitudinal monitoring of anti-inflammatory treatments in a swine model of IBD.

METHOD AND MATERIALS

Fourteen female swine with acute terminal ileitis induced by TNBS/ethanol solution at day 0 were randomized into 1) an anti-inflammatory treatment group (n=8 with meloxicam at 0.25mg/kg and prednisone at 0.5mg/kg; oral or intravenous, twice daily) and 2) a control group (n=6 without treatment). USMI was performed with a clinical machine (Acuson Sequoia 512; 15L8W, 7MHz; Siemens) after intravenous injection of MBselectin (5x108/kg). Three bowel segments per swine were imaged each at baseline, day 1, 3 and 6 after inflammation induction. Imaging signal was quantified as the difference between pre- and post-destructive signal intensity with VueBox software (Bracco) and normalized to day 1. At day 6 after imaging, scanned ileal segments were analyzed ex vivo for expression level of P-selectin using immunofluorescence staining.

RESULTS

Background USMI signals at baseline day 0 were not significantly different (P=0.09) between the two groups. At day 1, USMI signals significantly (P<0.05) increased in both groups and were not significantly different (P=0.9) between both groups. At day 3, signals significantly (P=0.02 vs. day 1) decreased in the treatment group, while it remained high in controls (P=0.25) and was significantly higher (P=0.001) compared to the treatment group. At day 6, signals further decreased in the treatment group; signals also dropped in controls due to known spontaneous decrease of inflammation in this model, but it remained significantly higher (P=0.046) compared to the treatment group. Immunofluorescence staining demonstrated significantly (P=0.004) higher P-selectin expression level in control versus treated ileum.

CONCLUSION

Dual-selectin targeted USMI allows longitudinal monitoring of anti-inflammatory treatment effects in a swine model of acute ileitis.

CLINICAL RELEVANCE/APPLICATION

This study paves the way for clinical translation of this radiation-free technique for monitoring IBD in patients.

SSK12-07 Sepsis of Unknown Origin: A Role of 18F-FDG-PET/MRI in Immunocompromised Patients

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S504CD

Participants
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Eva Ferdova, MD, Plzen, Czech Republic (*Abstract Co-Author*) Nothing to Disclose
Jan Baxa, MD, PhD, Plzen, Czech Republic (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate a diagnostic value of the PET/MRI in detection of cause of the septic state in patients with immunodeficiency

METHOD AND MATERIALS

There were performed 20 18F-FDG-PET/MRI examinations in patients including two children (the age 7-69 year, 13 females, 8

males) who suffered from signs of sepsis, and the cause was remained unclear after routine examinations. The procedures were performed using integrated PET/MRI system after application of the 18F-FDG with the dose of 2.5 MBq/kg. The examinations had to be performed under general anesthesia in 5 patients. The imaging protocol contained gradient echo T1 (VIBE) and T2 STIR sequences before application of the gadolinium contrast. The application of macrocyclic gadolinium containing contrast agent was used with the dose of 0.1 mmol/kg in those patients in whom the renal impairment was not present. PET data acquisition took 4 minutes in each position. When the suspected inflammation of the brain or spine was suspicious, the targeted imaging was performed. The imaging findings were compared with microbiology investigations or histological assessments

RESULTS

There were eleven patients immunocompromised after therapy of the hemato-oncological disease, four patients with advanced diabetes, three patients on long-term dialysis and two patients with congenital impairment of cellular immunity. The cause of the septic state was found in 90% of all cases. There were found seven cases of musculoskeletal infections caused by Staphylococcus (5), Enterococcus sp. (1), and Pseudomonas (1) infections. In four patients were found central nervous system infections including one patient with granulomatous inflammation of unknown agens and one patient with Toxoplasma meningitis. Other single causes included lung aspergillosis, abdominal Salmonella abscess, mycobacterial lymphadenitis. In three patients, the recurrent hematological malignancy was found, the disseminated renal cell carcinoma was found in one patient. The cause of septic state remained undetected in two patients. The results of imaging trigger therapy in 16 patients.

CONCLUSION

18F-FDG-PET/MRI could play an important role in detection of the cause of septic state in immunocompromised patients and in the therapy decisions.

CLINICAL RELEVANCE/APPLICATION

The advantage of the combination of PET and MRI lies especially in the detection of central nervous system and musculoskeletal infections.

SSK12-08 MRI Detection of Brain Abscesses and Monitoring of Antibiotic Treatment Using Endogenous Bacterial CEST Contrast

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S504CD

Participants
Jing Liu, Baltimore, MD (*Presenter*) Nothing to Disclose
Peter C. Van Zijl, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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Shui Xing Zhang Sr, MD, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Yuguo Li, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To develop an endogenous CEST MR imaging strategy to detect bacterial infections and to monitor their antibiotic treatment in deep organs, and to evaluate it in a preclinical animal model.

METHOD AND MATERIALS

Brain abscesses were developed by stereotactically injecting 6x106 *S. aureus* in the brains of F344 rats (3 mm left, 2 mm anterior of Bregma). After well circumscribed lesions were formed on ~ 9 days [1], rats received the ampicillin treatment at a daily dose of 30 mg/kg (*i.p.*) twice a day for 10 days. A F98 brain tumor model was established by injecting 5x104 F98-luc cells (3 mm right, 2 mm anterior of Bregma). MRI assessments were conducted before, 4 days and 10 days after the treatment. CEST MRI weighted images were acquired using a 3-sec CW pulse (B1= 1 and 3 μT) according to previously published methods [2].

RESULTS

As shown in Fig.1A, endogenous CEST contrast at 2.6 ppm allowed the *in vitro* MRI detection of three types of gram positive bacteria (*C. novyi-NT* [2], *S. aureus* and *S. epidermidis*) with slightly differing CEST patterns, as well as the *in vivo* visualization of brain abscesses formed by *S. aureus* (Fig.1C). Currently, differentiation of bacterial infection and brain tumors remains a formidable clinical challenge. In CEST MRI, while both type lesions showed higher CEST contrast than brain parenchyma, bacteria and tumors cells showed different CEST-dependence on the B1 strengths used for RF irradiation in CEST, likely attributed to the difference in cell composition and metabolism, which was utilized to differentiate them successfully (Figs. E-H). Finally, we investigated the longitudinal CEST signal changes during antibiotic treatment. As shown in Figs. I&J, CEST signal decreased markedly in the animals receiving amoxicillin treatment and, in contrast, remained constantly in the control group.

CONCLUSION

The endogenous CEST contrast of bacteria cells enables the direct and specific MRI assessment of bacterial infections of *S. aureus* in animal models. Moreover, this method allows non-invasive monitoring of bacteria responses to antibiotic treatments. References (1) Flaris, N. A.; Hickey, W. F. Am J Pathol 1992, 141, 1299-307. (2) Liu, G., et al. Magn. Reson. Med. 2013, 70, 1690-8.

CLINICAL RELEVANCE/APPLICATION

Endogenous CEST MRI contrast of bacterial cells provides a new clinically compatible imaging strategy for the diagnosis and treatment monitoring of bacterial infections in deep-seated organs.

SSK12-09 Developing a Novel Paramagnetic Fluorinated Nanoemulsion for Sensitive Imaging of Inflammation by Fluorine-19 Magnetic Resonance Imaging

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S504CD

Awards
Trainee Research Prize - Resident

Participants
Amin Haghighat Jahromi, MD, PhD, San Diego, CA (*Presenter*) Nothing to Disclose
Stephen R. Adams, PhD, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose
Kazim Narsinh, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Imaging of macrophages holds tremendous promise to address a variety of unmet diagnostic needs, such as imaging of cancer, cardiovascular disease, inflammatory disease, or tracking cells in vivo. 19F MRI of inflammation has emerged as an approach to locate macrophages using exogenous 19F probes in a highly specific and quantitative manner. We propose a novel nanoemulsion (NE) imaging probe for sensitive imaging of inflammation in vivo.

METHOD AND MATERIALS

We designed and synthesized a highly stable hexadentate chelating agent for iron (III). The structure of this complex was confirmed by NMR and x-ray crystallography. We added the iron (III) complex to perfluorooctyl bromide (PFOB) to form paramagnetic PFOB (P-PFOB) NE. (PFOB has been used previously in the clinic as a 19F tracer.) The NE was formed using high shear microfluidization to yield a monodispersed oil-in-water NE. Relaxation time 19F NMR measurements (9.4 T and 3 T) and in vitro cell apoptosis assays where used to characterize the nanoemulsion. Inflammation was induced in a murine model via a subcutaneous plug of Matrigel mixed with lipopolysaccharide in the neck. NE was subsequently injected intravenously and 11.7 T MRI data were acquired 24 h later using 2D chemical shift imaging (CSI).

RESULTS

Addition of Fe3+ chelate to PFOB dramatically enhanced 19F MRI detection sensitivity by reducing the 19F T1 by an order of magnitude. T1 values at 3 T are reduced from 1266 ms (PFOB) to 199 ms (P-PFOB, [Fe3+]= 3.5 mM) with minimal T2 line broadening; the effect diminishes at higher fields. In vitro cell assays confirmed viability of NE-labeled macrophages. Upon intravenous injection of P-PFOB NE, accumulation of the agent in the Matrigel plug was observed by 19F MRI, corresponding to the inflammation site. A linear [Fe3+]-dependent chemical shift was also observed in the PFOB fluorine peaks, which enables simultaneous tracking of various subtypes of cells via CSI.

CONCLUSION

We developed P-PFOB, capable of forming NE, with enhanced 19F MRI detection sensitivity over PFOB. By shortening T1, more signal averaging in a given scan time is possible. P-PFOB can also serve as a chemical shift agent for tracking various subtypes of immune cells.

CLINICAL RELEVANCE/APPLICATION

P-PFOB NE is a novel 19F MRI probe with greatly enhanced sensitivity for imaging inflammation and can be used to track various subtypes of immune cells in vivo.

SSK13

Musculoskeletal (Intervention)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: E353C

IR MR MK US

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Luca Maria Sconfienza, MD, PhD, Milano, Italy (*Moderator*) Travel support, Bracco Group; Travel support, Esaote SpA; Travel support, ABIOGEN PHARMA SpA
Daria Motamedi, MD, Washington, DC (*Moderator*) Nothing to Disclose

Sub-Events

SSK13-01 CT Guided Pulsed Radiofrequency Treatment of the Lumbar Dorsal Root Ganglion in Patients with Acute Radicular Lower Back Pain

Participants
Alessandro Napoli, MD, Rome, Italy (*Presenter*) Nothing to Disclose
Roberto Scipione, MD , Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Hans Peter Erasmus, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Cristina Marrocchio, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Susan Dababou, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To determine the clinical impact of CT-guided Pulsed Radiofrequency in the management of patients with acute or sub-acute neuro-radicular pain from lumbar disc herniation, refractory to usual therapeutic strategies.

METHOD AND MATERIALS

Patients were eligible for this single-center prospective study if they presented acute or sub-acute neuro-radicular low back pain (EMG confirmed), refractory to usual treatments (drugs and injections), and if they could safely undergo Pulsed Radiofrequency procedure. Treatment was performed using a 22-20 G needle-electrode with probe tip directed to the symptomatic DRG under CT guidance; E-pulsed radiofrequency (Cosman G4) was administered for 10 min at 45V with constant local temperature of 42°C. Clinical evaluation was conducted with Visual Analogue Scale (VAS), Owestry Disability Index (ODI) and Roland-Morris (RM) score for quality of life assessment; all questionnaires were obtained at baseline and at 1-week, 1-month and 3-month follow-up. Analyses were performed on a per-protocol basis.

RESULTS

Over a 3-year period, 80 patients were treated with Pulsed RadiofrequencyMedian VAS scores decreased from 7.8 at baseline to 3.5 at 1week after treatment, to 2.6 at 1 month and 1.3 at 3 months; median ODI scores decreased from 78.0 at baseline to 12.5 at 1 week, to 6.0 at 1 month and 5.5 at 3 months; RM score decreased from 16 at baseline to 3 at 1 month and 1.5 at 3 months ($p<0.001$). Overall, 90.0% of patients reached a 0 VAS score within the first month after treatment; 97.5% of patients had a decrease of at least 20 points in ODI score in the same interval. There were 6 patients considered partial responders that required a second PRF session.

CONCLUSION

CT-guided Pulsed Radiofrequency has shown to be a minimally invasive, effective and repeatable percutaneous treatment option for patients with acute or sub-acute neuro-radicular low back pain.

CLINICAL RELEVANCE/APPLICATION

the results of this study are superior to those reported from literature for usual care strategies and injections and may avoid surgery for a substantial number of patients with sciatic disc compression.

SSK13-02 Effects of Allogeneic Human Chondrocytes Expressing TGF-ß1 (TG-C) On Structural Progression of MRI Features Of Knee Osteoarthritis: A Randomized Clinical Trial

Wednesday, Nov. 29 10:40AM - 10:50AM Room: E353C

Participants
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PURPOSE

To determine effects of allogeneic human chondrocytes expressing TGF-ß1 (TG-C) on structural progression of MRI features of knee osteoarthritis over a 1 year period.

METHOD AND MATERIALS

This phase II randomized controlled trial of TG-C included patients with moderate to advanced osteoarthritis. Patients were randomized to receive an intraarticular 3:1 mixture of non-transduced allogeneic human chondrocytes and TG-C or placebo. 3T MRI was acquired for all patients at baseline and follow-up (3, 6 and 12 months). MRIs were assessed using the WORMS system including cartilage damage, bone marrow lesions (BMLs), meniscal damage/extrusion, Hoffa-, effusion-synovitis, and osteophytes. Analyses were performed on a whole knee level, compartmental level, and subregional level. Binary logistic regression with Generalized Estimating Equation was used to compare risks of progression, adjusting for baseline age and gender. Mann-Whitney-Wilcoxon tests were used to assess differences for continuous variables.

RESULTS

57 Patients were included in the TG-C group and 29 in the placebo group. At 12 months, knees in the TG-C group showed less progression of cartilage damage compared to placebo on a whole knee level (34.6% vs. 47.9%; adjusted RR 0.7, 95%CI [0.5-1.1], p=0.077). Less progression of Hoffa-synovitis and effusion-synovitis was observed in the TG-C group compared to placebo (9.6% vs. 21.1%, adjusted RR 0.5, 95%CI [0.2,1.2], p=0.115). No statistically significant differences were seen for BMLs, meniscal damage and osteophytes.

CONCLUSION

Intraarticular treatment with TG-C showed fewer patients in the treated group with progression in structural OA features and other MRI-defined inflammatory markers such as Hoffa-synovitis and effusion-synovitis. However, no differences were observed in regard to progression of BMLs and meniscal damage, or hypertrophic osteophyte formation.

CLINICAL RELEVANCE/APPLICATION

Intraarticular treatment with TG-C may potentially show benefits on delayed progression of cartilage damage and MRI markers of inflammation in osteoarthritis.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ali Guermazi, MD, PhD - 2012 Honored Educator

SSK13-03 MR Guided High Intensity Focused Ultrasound (MRgFUS) for the Treatment of Oligometastatic Prostate Cancer Bone Metastasis: Can Soundwaves Downstage Cancer Spread?

Wednesday, Nov. 29 10:50AM - 11:00AM Room: E353C

Participants
Carola Palla, MD , Rome, Italy (*Presenter*) Nothing to Disclose
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Cristina Marrocchio, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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Fabrizio Andrani, MD , Roma, Italy (*Abstract Co-Author*) Nothing to Disclose
Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

With improvements in diagnostic modalities such as functional imaging, oligometastatic prostate cancer is being diagnosed with greater frequency than ever before. Our aim was to determine MRgFUS ability to downstage patients with oligometastatic bone disease with single session of non-invasive metastasis-directed therapy.

METHOD AND MATERIALS

The study was designed with intention-to-treat metastatic bone lesions. Patients were enrolled if they had accessible bone metastasis and could safely undergo MRgFUS (InSightec, Israel). Baseline measurable characteristics included dynamic contrast enhanced MRI study (Gd-BOPTA, Bracco; GE 750 3T magnet) with semiquantitative perfusion analysis, PSA level (ng/ml) and choline PET (SUV). Measurable variables were obtained at treatment time, 3 months, 12 months and 24 months follow-up.

RESULTS

18 patients fulfilled the inclusion criteria and safely underwent MRgFUS procedure of metastatic bone ablations. Lesions were located in the pelvis (11), scapula (3) and long bones (4). At baseline all lesions showed a significant DCE perfusion (highly vascular) with mean perfusion reduction of 88% at 3 months follow-up (CI: 100-50; $p<0.001$) stable at subsequent follow-up scans. Similarly PSA levels decreased from a mean baseline of 19 (ng/ml) to 7.1, 2.9 and 2.1, at 3-12 and 24 moths respectively. SUV values showed similar trend with reduction from baseline (mean 8.9 to 3.0, 2.3 and 1.7: $p<0.001$). In all patients single MRgFUS session was appropriate without any major or minor adverse events reported.

CONCLUSION

MRgFUS is a totally non-invasive procedure that can obtain nearly complete bone ablation in patients with oligometastatic prostate disease. The technique features a radiation-free approach that can be of incremental value in long-survivor subset on oncological patients, significantly reducing risk of toxic effects.

CLINICAL RELEVANCE/APPLICATION

MRgFUS could be routinely introduced as a treatment option for oligometastatic bone disease non responding to conventional treatment.

SSK13-04 Image-guided Spine Injections: Paradoxical Particle Formation of Ropivacaine and Non-Particulate Dexamethasone Poses a Risk for Spinal Cord Infarction Events

Wednesday, Nov. 29 11:00AM - 11:10AM Room: E353C

Participants
Brandon Childers, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
Il Minn, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Jace Jones, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Maureen Kane, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Jan Fritz, MD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG; Scientific Advisor, Siemens AG; Scientific Advisor, Alexion Pharmaceuticals, Inc; Speaker, Siemens AG

PURPOSE

Image-guided epidural steroid injections are frequently performed radiologic procedures using local anesthetics and steroids. Because particulate steroids can embolize into the arterial system and cause rare cord infarction events, non-particulate steroids are now recommended. However, we have observed paradoxical particulation when mixing the non-particulate steroid dexamethasone and the local anesthetic ropivacaine, posing a risk for cord infarction events despite using recommended non-particulate injectables. Therefore, we investigated the occurrence of particulation between different local anesthetics and non-particulate dexamethasone formulations, as well as the mechanism of action.

METHOD AND MATERIALS

We evaluated clinically relevant dilution series (1:1 - 1:10) of commercially available ropivacaine (2), lidocaine (2) and bupivacaine (1) formulations mixed with three different commercially available dexamethasone formulations. The outcome variables were the pH of the native drugs and mixtures as well as the presence of precipitation using macroscopic inspection and microscopic photography. Mass spectroscopy was used to analyze the composition of ropivacaine-dexamethasone precipitate.

RESULTS

The pH of the native formulations and mixtures were acidic for ropivacaine, and near neutral for bupivacaine, lidocaine, and dexamethasone. All mixtures were pH neutral. Both ropivacaine formulations demonstrated particulation at all concentrations when combined with two dexamethasone formulations, whereas only minimal particulation occurred at concentrations of 1:1-2 of ropivacaine and the third dexamethasone formulation. Bupivacaine showed minimal, wall-adherent crystal formation with only one dexamethasone formulation at concentrations of 1:1-2. Lidocaine did not form any particles. Mass spectroscopy identified the particles as pure ropivacaine precipitate.

CONCLUSION

Ropivicaine precipitates out of solution and forms particles when combined with dexamethasone, owing to a change from acidic to neutral pH. However, the degree of particulation varies based upon the commercially-available formulations, suggesting that other factors may also play a role.

CLINICAL RELEVANCE/APPLICATION

The combination of non-particulate ropivacaine and non-particulate dexamethasone formulations should be avoided when performing epidural steroid injections to prevent particle formation and minimize the risk of embolic cord infarction events.

SSK13-05 Greater Occipital Nerve Infiltration under MR Guidance: Feasibility Study and Preliminary Results

Wednesday, Nov. 29 11:10AM - 11:20AM Room: E353C

Participants
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Bruno A. Kastler, MD, PhD, Besancon, France (*Abstract Co-Author*) Nothing to Disclose
Jan Fritz, MD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG; Scientific Advisor, Siemens AG; Scientific Advisor, Alexion Pharmaceuticals, Inc; Speaker, Siemens AG
Caroline Maindet, Grenoble, France (*Abstract Co-Author*) Nothing to Disclose
Stephan Chabardes, Grenoble, France (*Abstract Co-Author*) Nothing to Disclose
Alexandre Krainik, MD, PhD, Grenoble Cedex, France (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the feasibility of greater occipital nerve (GON) intermediate site infiltration with MRI guidance

METHOD AND MATERIALS

Eleven consecutive patients suffering from chronic refractory cranio-facial pain who underwent 16 GON infiltrations between November 2016 and January 2017 were included in this prospective study. All of the procedures were performed on an outpatient basis in the research facility of our institution, equipped with a widebore 1.5T scanner. The fatty space between inferior obliquus and semispinalis muscles at C1-C2 level was defined as the infiltration target. Technical success was defined as the ability to accurately inject the products in the pre-defined target, assessed by post procedure axial and sagittal proton density weigthed sequences. Clinical success was defined as a 50% pain decrease at one month follow up.

RESULTS

Technical success as defined above was 100%. GON was depicted in 6 of 11 cases on planning MRI sequences. Mean duration of procedure was 22.5 minutes (range-16-41). Clinical success as previously defined was obtained in 7 of 11 included patients (63.6%) with a mean self reported improvement of 78%.

CONCLUSION

Interventional MR guidance for GON infiltration is a feasible technique offering similar results to an already established effective procedure. It may appear as a useful tool in specific populations, such as young patients and repeat infiltrations, and should be considered in these settings.

CLINICAL RELEVANCE/APPLICATION

• MR guidance for GON infiltration is a feasible technique • Preliminary results are in agreement with other guidance modalities • MR guidance may be seen as a useful tool in specific populations

SSK13-06 Cementoplasty of Pelvic Bone Metastases: Lesion Filling and Other Factors Influencing the Therapeutic Response

Wednesday, Nov. 29 11:20AM - 11:30AM Room: E353C

Participants
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PURPOSE

To determine the parameters likely to influence the therapeutic response in cementoplasty of pelvic metastases.

METHOD AND MATERIALS

We retrospectively reviewed a series of pelvic bone cementoplasties performed for symptomatic metastatic involvement in the last 7 years. In addition to demographics, primary tumor and associated treatments, we collected information on the lesion treated: localization, dimensions, cortical destruction graded 0-6, soft tissue mass and pathological fracture; and procedural information: number of needles, cement volume, filling percentage and extra-osseous leakage. The pain scores were evaluated on a visual analog scale before treatment and at the 1 month follow-up visit.

RESULTS

We included 44 procedures in 40 patients (21 females and 19 males, mean age 63 years). The primary tumor was lung (n = 15), breast (n = 9), kidney (n = 7), thyroid (n = 2) or other (n = 7). There were 38 osteolytic and 6 mixed lesions. Localization was acetabular (n = 30), iliac (n = 11) or sacral (n = 3). The maximal lesion diameter was on average 43 mm. The cortical destruction was on average 2.4 / 6 with soft tissue extension in 7/35 and pathological fracture in 7/35. The number of needles was one in 32/44, two in 10/44 and three in 2/44. The volume of cement injected was on average 10 ml with an average filling of 55%. A cement leak was minimal in 11/44, moderate in 9/44. Pain relief was observed in 74% of patients with an average score of 84/100 before the procedure and 46/100 after. The pain relief did not appear correlated to lesion volume (p = 0.2), presence of pathological fracture (p = 0.3), soft tissue extension (p = 0.21), filling percentage (p =0,42), cement leak (p = 0,26), or previous radiation therapy (p = 0,8).

CONCLUSION

Cementoplasty of pelvic bone metastases provides pain relief in a majority of patients. The lesion filling can be optimized by injection through multiple needles but this parameter does not appear correlated with the therapeutic response.

CLINICAL RELEVANCE/APPLICATION

Cementoplasty is a valuable adjunct in the management of symptomatic pelvic bone metastases.

SSK13-07 Hip Steroid/Anesthetic Injections: Is there an Increased Incidence of Hip Osteoarthritis Progression, Femoral Head Osteonecrosis and Collapse?

Wednesday, Nov. 29 11:30AM - 11:40AM Room: E353C

Participants
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PURPOSE

To evaluate incidence of osteoarthritis progression, femoral head osteonecrosis and articular surface collapse in hip steroid/anesthetic injection patients.

METHOD AND MATERIALS

Our study was IRB-approved and HIPAA compliant. A total of 123 hip steroid/anesthetic(40 mg triamcinolone, 4 mL 0.5%

preservative free ropivicaine) injections were performed from 01/2014 to 07/2015. Inclusion criterion was follow-up radiography of the native hip 3-9 months after the injection. Two musculoskeletal radiologists performed retrospective, blinded reviews of the pre- and post-injection radiography of hip injection patients (HIPs) and 2 demographic and follow-up duration matched control groups: 1, patients undergoing hip x-rays without injection; 2, glenohumeral joint injection patients. Groups were compared with Fisher exact test.

RESULTS

There were 102 HIPs (age 65 ± 13 (range 19-92) years; 62 F, 40 M; 41 L, 61 R), who were followed for 26 ± 10 (12-66) weeks. For Reader 1, 38/102 (37%) of HIPs had increased osteoarthritis after steroid injection, compared with 27/102 (26%) of hip controls and 14/44 (32%) of shoulder injection patients. For Reader 2, 42/102 (41%) of HIPs had increased osteoarthritis after steroid injection, compared with 20/102 (20%) of hip controls and 10/44 (23%) of shoulder injection patients. There was no significant difference between these groups (P>0.05). For Reader 1, 24/102 (24%) of HIPs had new osteonecrosis and 15/102 (15%) had new collapse after the steroid injection, compared with 9/102 (9%) and 4/102 (4%) of hip controls and 2/44 (5%) and 1/44 (2%) of shoulder injection patients. There was significantly more osteonecrosis and collapse in HIPs, compared with hip controls (P=0.001 and 0.01) and shoulder injection patients (P = 0.005 and 0.04). For Reader 2, 22/102 (22%) of HIPs had new osteonecrosis and 17/102 (17%) had new collapse after the steroid injection, compared with 9/102 (9%) and 4/102 (4%) of hip controls and 2/44 (5%) and 1/44 (2%) of shoulder injection patients. There was significantly more osteonecrosis and collapse in HIPs, compared with hip controls (P=0.01 and 0.01) and shoulder injection patients (P = 0.03 and 0.005).

CONCLUSION

Hip injection patients have a greater incidence of osteonecrosis and collapse compared with hip controls and shoulder injection patients.

CLINICAL RELEVANCE/APPLICATION

Further evaluation of hip injectates and the injection population is warranted, given these findings.

SSK13-08 MRI-Guided High Intensity Focused Ultrasound: A New First-Line Technique in the Treatment of Osteoid Osteoma?

Wednesday, Nov. 29 11:40AM - 11:50AM Room: E353C

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

to demonstrate that completely non-invasive radiation-free ablation of osteoid osteoma with MRI-guided high intensity focused ultrasound (MRgFUS) is a safe, effective and durable treatment option.

METHOD AND MATERIALS

Patients with typical clinical and radiological diagnostic findings of osteoid osteoma (non-vertebral), suitable for MRgFUS and anaesthesia, were enrolled in this dual-centre prospective observational study. Vertebral locations were excluded as considered inaccessible. MrgFUS was performed using InSightec ExAblate 2100 system. Safety (rate of complications), clinical effectiveness (Visual Analogue Scale [VAS] pain score reduction) and durability (stability of results over time) of MRgFUS were evaluated as primary outcomes; tumour control (nidus ablation) at dynamic contrast enhanced MR imaging (Discovery 750, GE; Gd-BOPTA, Bracco) was considered as secondary outcome. All patients underwent a minimum follow-up period of 4 years.

RESULTS

Out of 50 subjects screened for recruitment, 45 were enrolled and submitted to MRgFUS. No treatment-related complications were observed. A complete and durable response was achieved in 80% of cases. Median VAS pain score dropped from 8 (IQR 7-9) to 0 at 1-week, and at all subsequent follow-up check points (1 month, 6, 12, 24, 36 and 48 months). Scores evaluating interference of pain with sleep, physical and daily activities showed similar improvement after treatment. Among subjects with partial response (20%), 4 received a second treatment (3 with CT-guided Radiofrequency Ablation, 1 with MRgFUS), and 5 did not need any other treatment. All re-treated patients achieved 0 VAS score. Overall, 87% of patients after MRgFUS treatment reached and maintained a stable 0 VAS score during follow-up. At 3-year MRI osteoid osteoma showed no vascularization in 32/42 patients (76%) treated with MRgFUS alone.

CONCLUSION

MRgFUS is a safe, effective and durable option in the treatment of non-spinal osteoid osteoma.

CLINICAL RELEVANCE/APPLICATION

This technique provides relevant advantages in the treatment of this impairing disease affecting mostly young population: no ionizing radiation, no incisions or needles, and, so far, no complications. Our results support the role of MRgFUS as first-line treatment option for accessible osteoid osteoma.

SSK13-09 Imaging and Clinical Risk Factor Correlation with Rate of Conversion to Surgery Following Fluoroscopically Guided Facet Cyst Rupture

Wednesday, Nov. 29 11:50AM - 12:00PM Room: E353C

Participants
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PURPOSE

Facet cysts may be encountered at magnetic resonance imaging (MRI) in patients with back pain and radicular symptoms. The purpose of this study was to evaluate the conversion rate to surgery following cyst rupture, and to assess associated clinical, imaging and procedural variables.

METHOD AND MATERIALS

A retrospective review was completed of all patients who underwent fluoroscopically guided facet cyst rupture through access of the inferior facet recess from 2000-2016. Primary outcome was conversion to surgery. Secondary outcomes included clinical, MRI, and procedural variables possibly associated with conversion. Clinical variables included sex, age, # of comorbidities, symptoms (pain, motor, sensory), pain laterality, and if pain involved the leg, back or both. MRI variables included cyst size, shape, internal signal, rim signal, spine level, laterality, spondylolisthesis, canal or lateral recess stenosis, presence of facet fluid +/- unilateral vs. bilateral, bone edema and erosion. Procedural variables included cyst opacification, successful epidural rupture and pre vs. post procedure pain.

RESULTS

49 patients met the inclusion criteria. 4 were excluded because they had either no clinical notes or no MRI available for review. 13/45 (29%) of patients converted to surgery. Successful epidural rupture was observed fluoroscopically in 33/45 (73%), of whom 7/33 (21%) converted to surgery. No epidural rupture was seen in 12/45 (27%), of whom 6/12 (50%) converted to surgery. The average interval to surgery was 95 days and average follow up was 889 days after cyst rupture. Of the clinical, imaging and procedural variables evaluated, only the number of comorbidities was significantly associated with conversion to surgery ($p = 0.03$).

CONCLUSION

Facet cysts have been recognized as a cause of spinal stenosis. Fluoroscopically guided facet cyst rupture may be attempted prior to surgery, though 29% our patients eventually required surgery. No significant correlation was found between facet cyst features at MRI and conversion rate to surgery to aid in determining which patients may be benefit from intervention.

CLINICAL RELEVANCE/APPLICATION

Fluoroscopic guided facet cyst rupture is a minimally invasive procedure worth attempting in symptomatic patients as it has a high rate of technical success, with most patients avoiding surgery.

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SSK14

Nuclear Medicine (Breast and Gynecologic Imaging)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S505AB

BR CT MR NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Gary A. Ulaner, MD, PhD, New York, NY (*Moderator*) Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd
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Sub-Events

SSK14-01 Bridging the Gap between Digital Mammography and Molecular Breast Imaging

Awards
Student Travel Stipend Award

Participants
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Carrie B. Hruska, PhD, Rochester, MN (*Abstract Co-Author*) Institutional license agreement, Gamma Medica, Inc
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PURPOSE

To develop image processing algorithms and visualization tools to assist with the interpretation of molecular breast imaging (MBI).

METHOD AND MATERIALS

MBI images were first denoised using a state-of-the-art denoising pipeline. The pipeline consists of a variance stabilization step, followed by noise suppression using the block-matching 3D (BM3D) filter. Optimal denoising parameters were defined based on a subset of cases; a graphical user interface allows for dynamic adjustment of the sharpness and noise by the reader. The visualization software includes a computer-aided diagnosis (CAD) feature, which searches for bright regions on the denoised image and automatically highlights their positions for further investigation. To assist the translation between MBI and digital mammography (DM), a registration algorithm is used to determine an affine algebraic transformation that maps coordinates from the MBI images into coordinates on the DM images. The transformation can be used to highlight a region on the DM image based on a user selected location on an MBI image. Alternatively, the MBI may be fused with the corresponding DM images and displayed similar to PET CT images. A software prototype was implemented using MATLAB and evaluated using 18 patient cases.

RESULTS

The denoising algorithm improved the visualization of lesions with subtle uptake by suppressing noise with minimal signal smoothing. The CAD was capable of identifying areas of increased uptake in faint lesions. In this small test set, all lesions were marked; false-positive marks at the chest wall were noted in a minority of cases. The MBI registration resulted in good matches between MBI and DM images, based upon visual inspection of anatomic landmarks.

CONCLUSION

We have developed image processing algorithms and visualization tools for improving the interpretation of MBI images. It is important that MBI is combined with current technologies, such as DM and tomosynthesis, to improve the detection and characterization of lesions.

CLINICAL RELEVANCE/APPLICATION

Denoising may offer the potential to reduce MBI radiation dose and imaging time and increase tumor detectability. By co-registering MBI and DM images, ambiguities between the modalities are reduced, offering the potential to reduce false positive findings.

SSK14-02 Supine Breast PET-MR Imaging in a Whole-Body Approach: How Good is it Compared to Dedicated Breast PET MR Imaging

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S505AB

Participants
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PURPOSE

To evaluate the detection rate of breast tumor in supine breast MRI and supine breast 18F-FDG PET/MRI compared to diagnostic breast MRI and diagnostic breast 18F-FDG PET/MRI.

METHOD AND MATERIALS

A total of 32 patients (31 women, 1 man, mean age 38 years) with histopathologically confirmed breast cancer were included in this study. Each patient underwent a whole-body 18F-FDG PET/MR examination including dedicated diagnostic breast imaging in prone position and subsequently a whole-body MRI in supine position. We analysed the diagnostic performance of (1) dedicated prone breast MRI, (2) dedicated prone breast 18F-FDG PET/MRI (3) supine breast MRI and (4) supine breast 18F-FDG PET/MRI derived from a whole-body staging examination, on a per-patient and per-lesion basis.

RESULTS

Dedicated prone breast MRI and dedicated prone breast 18F-FDG PET/MRI correctly identified all 32 patients with breast cancer (100%). Supine breast MRI correctly identified 28/32 patients (87.5%), while supine breast 18F-FDG PET/MRI correctly identified 29/32 patients (90%). Based on the reference standard a total of 51 lesions were included for analysis. In both dedicated breast imaging examinations all lesions (100%) were identified with 2 additional false-positive findings. Supine breast MR imaging identified 36/51 lesions (70%) with 5 additional false-positive findings and supine breast 18F-FDG PET/MRI identified 40/51 lesions (78%) with 6 additional false-positive findings. The mean SUVmax for lesions in prone 18F-FDG PET/MRI was 3.4 and 4.2 in supine 18F-FDG PET/MRI.

CONCLUSION

Dedicated breast imaging in prone positioning with or without 18F-FDG information is superior to examinations in supine position. While 18F-FDG information did not improve the diagnostic value of dedicated prone breast MRI, adding 18F-FDG information to supine breast examination led to an increase of tumor detection but also of false positive findings.

CLINICAL RELEVANCE/APPLICATION

Dedicated prone breast (PET)MRI is superior to supine breast imaging, as supine breast (PET)MR imaging identifies less tumor lesions and elicits an increase of false-positive findings leading to potentially harmful biopsies.

SSK14-03 Correlation of Bone Marrow Fat Fraction Content using T1 Dixon and Changes in FDG with PET/MR in Breast Cancer Patients with Bone Metastases

Wednesday, Nov. 29 10:50AM - 11:00AM Room: S505AB

Participants
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PURPOSE

Bone metastases replace the normal fat of bone marrow which can easily be imaged with Dixon sequence. However, there is a lack of quantitative evaluation in the literature. We utilized Dixon sequence with FDG PET/MR to determine if change in fat content correlated with change in metabolic activity and if it could be used to assess treatment response.

METHOD AND MATERIALS

We retrospectively identified 7 females with osseous metastases from breast cancer who had pre- and post-treatment FDG PET/MR scans. Regions of interest were drawn around metastases on coronal T1 Dixon fat only images. Fat fraction of each lesion was measured using the ratio of signal intensity of metastases to signal intensity of the patient's normal psoas muscle as well as normal vertebral body. Change in fat fraction was then compared with change in PET SUV of each lesion.

RESULTS

32 bone metastases were identified on PET/MR scans in 7 females with breast cancer. 63% (n=20) of the lesions were in the spine, 22% (n=7) in the pelvis, and 15% (n=5) in the extremities. The average time between studies was 6 months. From pre-treatment

to post-treatment study, 25 lesions increased in FDG activity and 7 lesions decreased in FDG activity. 89% (22/25) of lesions with increasing metabolic activity demonstrated a decrease in fat fraction, with an overall average change in fat fraction of -56%. To the contrary, lesions with decreasing metabolic activity had an average change of +153% in fat fraction. A Wilcoxon rank-sum test revealed a significant difference in the change of fat fraction between the two groups with a p-value of 0.01. A Pearson correlation test between the percent change in SUV and change in fat fraction of each lesion revealed an r-value of -0.3. More specifically, 100% (7/7) of pelvic and 85% (11/13) of vertebral lesions with increased metabolic activity demonstrated a decrease in fat fraction.

CONCLUSION

Quantitative analysis of bone metastases in breast cancer patients reveals that fat fraction of lesions increases with significance as metastases improve and vice versa. However, a strong negative linear correlation did not exist between changes in metabolism and changes in fat fraction.

CLINICAL RELEVANCE/APPLICATION

Many breast cancer patients present in the late stages with osseous metastases. Measuring quantitative fat fraction changes in lesions can help follow up treatment response in bone metastases, especially when PET imaging is not available.

SSK14-04 Quantitative Evaluation of Metabolic Tumor Burden in Molecular Subtypes of Primary Breast Cancer with FDG PET/CT

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S505AB

Participants
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PURPOSE

To quantitatively evaluate volume-based metabolic tumor burden including metabolic tumor volume and total lesion glycolysis in different molecular subtypes of breast cancer and to compare the total lesion glycolysis before and after normalizing for lean body mass on 18F-FDG PET/CT.

METHOD AND MATERIALS

This study involved 99 female patients who were pathologically diagnosed with primary breast cancer and 18F-FDG PET/CT were performed before any therapy. The patients were divided into 4 subtypes including Luminal A, Luminal B, ERBB2+ and Basal-like according to the immunohistochemistry results. Metabolic tumor volume (MTV) and total lesion glycolysis (TLG) before and after correction for lean body mass (LBM) were achieved and compared. Correlations between metabolic tumor burden and the expression level of Ki-67 and p53 were analyzed. Diagnostic performance of volume-based metabolic parameters was evaluated using the receiver operating characteristic curve.

RESULTS

Group differences of the total lesion glycolysis were found between each molecular subtype of breast cancer, with the highest value in the subtype of Basal-like but there was no significant difference in metabolic tumor volume in subtypes of breast cancer. Values of total lesion glycolysis before and after correction for LBM were highly associated and significant reduction was found after correction of LBM for all subtypes of breast cancer. TLG after correction for LBM showed more close correlations with the expression level of Ki-67 and it presented higher diagnostic ability in identifying patients of Basal-like from those of non-Basal-like than that before correction.

CONCLUSION

Metabolic tumor burden could reflect the metabolic differences and predict prognosis of different molecular subtypes of breast cancer, especially total lesion glycolysis after correction for LBM. It could be used to help with differentiating patients in the subtype of Basal-like.

CLINICAL RELEVANCE/APPLICATION

Metabolic tumor burden is superior to daily used SUV and could comprehensively reflect the metabolic differences and predict prognosis of different molecular subtypes of breast cancer,

SSK14-05 Relationship between SUV Max and Gene Expression in FDG-PET/CT in Invasive Ductal Breast Cancer

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S505AB

Participants
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PURPOSE

To compare 18FDG uptake within invasive ductal breast carcinoma (IDC) with estrogen and progesterone receptor status, as well as epidermal growth factor (HER-2) gene expression.

METHOD AND MATERIALS

Over a 5-year interval, a total of 142 women with IDC, 1 cm or larger, underwent PET/CT imaging for staging purposes. From histopathology reports, all estrogen receptor (ER) and progesterone receptor (PR) status results were collected, as well as results of the human epidermal growth receptor 2 (HER-2) gene expression status. Four patient subgroups were formed. Group A (N=43) were ER negative/PR negative/HER-2 negative (i.e. 'triple negative'), group B (N=50) were ER positive/PR positive/HER-2 negative, group C (N=45) were ER positive/PR positive/HER-2 positive, group D (N=9) consisted of any other combination.

RESULTS

The triple-negative tumors had the highest SUV Max, ranging from 2.24 to 26.7, with a mean of 14.69. The ER positive/PR positive/HER-2 positive had the lowest SUV Max, ranging from 0.85-6.86, with a mean of 3.85.

CONCLUSION

As expected, triple negative IDC, as the most aggressive, demonstrated the highest glucose comsumption rate. By contrast, those tumors with combined estrogen, progesterone and HER-2 receptor activity demonstrates the lowest glucose consumption.

CLINICAL RELEVANCE/APPLICATION

There is a direct correlation between hormone and HER-2 receptor status and 18FDG uptake in invasive ductal breast cancers.

SSK14-06 A Patient-Centered Quality Initiative: Stepwise Modification of Departmental Protocol Culminating in a Single Periareolar Radiotracer Injection with Equally Effective Sentinel Node Detection While Reducing Procedural Pain

Wednesday, Nov. 29 11:20AM - 11:30AM Room: S505AB

Awards
Student Travel Stipend Award

Participants
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Arnold Brenner, DO, Staten Island, NY (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the effectiveness of multiple technical modifications of technique in performing preoperative axillary sentinel lymph node (SLN) mapping in breast cancer patients, with the endpoints of nodal detection sensitivity and perceived procedural pain.

METHOD AND MATERIALS

A superficial injection of radiotracer 99Tc- ultra-filtered sulfur colloid was used. Stepwise optimization of this technique resulted in a standardized injection protocol with a tracer dose of 1 mCi, administered through a single periareolar intradermal injection of 0.1 mL using a TB syringe and a 26G needle. Additional modification included the use of benzocaine topical anesthetic spray. Over a 6 year period (2011 - 2017), the number of periareolar injections performed was reduced stepwise from 4 injection sites to 1 injection site and this final refinement was analyzed for SLN detection sensitivity and perceived pain, using our institutional pain scale ranging from 0-10.

RESULTS

682 women with invasive breast cancer who underwent consecutive preoperative axillary SLN mapping were included (mean age 63, range 31-90). Laterality of breast injection site included 263 in the right breast, 287 in the left breast and 132 in bilateral breasts. Axillary SLN was visualized with detection sensitivity of 100%. In women who had 4 injection sites in a unilateral breast or 8 injections in bilateral breasts (n= 180), the mean reported pain score was 4.6 (range 0-10). Women with 3 injection sites in a unilateral breast or 6 injections in bilateral breasts (n= 214) and 2 injection sites in a unilateral breast or 4 injections in bilateral breasts (n= 196) have a mean reported pain score of 3.7 and 3.2, respectively (range 0-10). Women who had only 1 injection in a unilateral breast or 2 injections in bilateral breasts (n= 92) reported a mean pain score of 2.4 (range 0-8). A decrease in the number of injection sites from 4 to 1 reduced the mean pain score by 48% (p-value < 0.0001).

CONCLUSION

Multiple sequential technical modifications culminating in a single periareolar injection technique for axillary SLN mapping reduces periprocedural pain while maintaining 100% SLN detection sensitivity.

CLINICAL RELEVANCE/APPLICATION

A stepwise modification of technique resulting in a single periareolar intradermal injection reduces periprocedural pain while maintaining 100% axillary sentinel lymph node detection sensitivity.

SSK14-07 Value of Intratumoral Metabolic Heterogeneity and Quantitative 18F-FDG PET/CT Parameters to Predict Prognosis in Patients with Cervical Cancer

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S505AB

Participants
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PURPOSE

To evaluate the impact of intratumoral metabolic heterogeneity and quantitative FDG PET/CT parameters for predicting patient outcomes in cervical cancer.

METHOD AND MATERIALS

This ongoing IRB and HIPPA complaint retrospective study included a total of 120 patients with biopsy proven squamous cell carcinoma of the cervix who had a FDG PET/CT for initial staging. Automated gradient-based segmentation method was used to assess the primary tumor standardized uptake value maximum and peak (SUV max and SUV peak), metabolic tumor volume (MTV) and metabolic intratumoral heterogeneity index, calculated as the area under cumulative SUV-volume histograms (AUC-CSH), with lower AUC-CSH indexes corresponding to higher degrees of tumor heterogeneity. Patient's demographics and tumor staging were also collected. Median follow up time was 27.5 months. Overall survival (OS) and progression free survival (PFS) were calculated using multivariate cox proportion hazard regression model and log-rank (Mantel-Cox) test to generate Kaplan-Meier survival plots.

RESULTS

The patients' mean age was 54.4 ± 13.1 years and there were 27 patients with stage I, 53 with stage II, 23 with stage III and 17 with stage IV disease. Median survival was 74.9 months. Thirty three patients died and 82 were alive (for 5 patient no information on survival available). Higher MTV was significantly associated with reduced OS in the multivariate analysis for every 10 mL increase in volume (HR=1.084, 95% CI=1.036-1.134, p=0.0005). Higher AUC-CSH (lower tumor heterogeneity) was significantly associated with increased PFS in the multivariate analysis for every 1000 increase in the area under the curve (HR=0.679, 95% CI=0.468-0.968, p=0.042). Kaplan-Meier survival analysis using the median value for MTV (74.7 mL) significantly predicted OS (HR = 2.839; 95% CI =1.33-6.02; p=0.0045) and using median value for AUC-CSH of 5602 significantly predicted PFS (HR = 0.469; 95% CI =0.226-0.973; p=0.03).

CONCLUSION

MTV segmented by gradient method is significantly associated with overall survival and tumor heterogeneity is associated with progression free survival for patients with cervical cancer.

CLINICAL RELEVANCE/APPLICATION

FDG PET/CT quantitative parameters can provide prognostic information on initial staging scan, potentially leading to a more personalized approach for patient's treatment.

SSK14-08 18F-FDG PET/MRI vs MRI Alone in Whole-Body Staging of Seventy-One Patients with Suspected Recurrent Gynecologic Pelvic Cancers

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S505AB

Participants
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PURPOSE

To evaluate the diagnostic performance of whole-body 18F-fluordesoxyglucose positron emission tomography/magnetic resonance imaging (18F-FDG PET/MRI) for whole-body staging of suspected recurrent gynecologic pelvic cancer in comparison with whole-body MRI alone.

METHOD AND MATERIALS

Seventy-one consecutive female patients (54 ± 13 years) with suspected recurrence of cervical (32), ovarian (26), endometrial (7), vulvar (4), and vaginal (2) cancer prospectively underwent whole-body PET/MRI including a diagnostic contrast-enhanced MRI protocol. PET/MRI and MRI datasets were separately evaluated regarding lesion count, localization, categorization (benign/malignant), and diagnostic confidence (4-point scale; 0 - 3) by two radiologists. The reference standard was based on histopathological results and follow-up imaging. Proportions of lesions rated correctly were compared on a per-patient and per-lesion basis using McNemar's chi2 test. Differences in diagnostic confidence were assessed by Wilcoxon test.

RESULTS

Fifty-five patients had cancer recurrence. PET/MRI and MRI alone correctly identified 55/55 (100 %) and 46/55 (83.6 %) patients with cancer recurrence, respectively. A total of 241 lesions were described on the reference standard, including 181 malignant and 60 benign lesions. PET/MRI detected all 241 lesions, whereas only 186/241 lesions (77.2 %) were detectable on MRI alone. PET/MRI provided correct identification of all 181 malignant lesions. Instead, MRI alone correctly identified only 126/181 (69.6 %) malignant lesions, which was significantly less compared with PET/MRI ($p < 0.001$). PET/MRI offered significantly higher diagnostic confidence in the categorization of malignant lesions compared with MRI alone ($p < 0.001$).

CONCLUSION

PET/MRI demonstrates excellent diagnostic performance and outperforms MRI alone in staging of patients with suspected recurrent gynecologic pelvic cancers.

CLINICAL RELEVANCE/APPLICATION

PET/MRI enables exact assessment of recurrence of female pelvic malignancies and should be considered a valuable alternative for whole-body staging of patients with suspected recurrent disease.

SSK14-09 First-in-Human Biodistribution and Dosimetry of In-111/Y-90-FF-21101: A Radioimmunotherapeutic Agent Targeting P-cadherin

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S505AB

Participants
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PURPOSE

To assess the human biodistribution and dosimetry of 111In/90Y-FF-21101, a human-mouse chimeric monoclonal antibody directed against P-cadherin, encoded by CDH3 gene-overexpressing solid tumors.

METHOD AND MATERIALS

Ten patients (4 male, 6 female) in a first-in-human dose-escalation (5, 10, 15, 20, 25 mCi/m2 <= 60 mCi) 90Y-FF-21101 clinical trial, underwent a 5 mCi 111In-FF-21101 pre-treatment dosimetry study. Whole-body planar (WB) scans were acquired at 0.25, 4, 24, 72 and 144 h on a Siemens Symbia S camera. A two-bed SPECT scan was acquired at 24-h, calibrated with a 10 ml vial containing 50 µCi of 111In, to compute organ absolute activity. (A CT scan was acquired on a General Electric 750 HD scanner for SPECT attenuation correction and fusion.) Blood samples were collected at 0.5, 1, 2, 4, 24, 72 and 144 h, for estimating marrow dose. Time-activity curves (TACs) were generated from two-dimensional regions of interest drawn on the WB images around the heart contents, lungs, liver, spleen, kidneys, testes and total body. Three-dimensional volumes of interest for the lungs, liver, spleen and kidneys were defined on the SPECT/CT images, to activity-correct planar TACs and estimate organ masses for the dosimetric analysis. Source organ and marrow 111In and 90Y residence times derived from TAC exponential fits were entered into OLINDA/EXM v1.1 for dose calculation (mSv/MBq), with mass correction for liver, kidneys, spleen and lungs. Tumor uptake was assessed qualitatively.

RESULTS

The five highest mSv/MBq for 111In were: spleen (M:2.55,F:2.66); kidneys (M:0.77,F:0.76); testes (M:0.62) and liver (F:0.64); liver (M:0.62) and lungs (F:0.52); and pancreas (M:0.57,F:0.47); and for 90Y were: spleen (M:23.4,F:28.5); testes (M:8.56) and kidneys (F:6.42); kidneys (M:6.48) and lungs (F:5.09); liver (M:4.34,F:4.66); and lungs (M:4.12) and heart wall (F:2.66). Tumor uptake was visualized in 6 of 10 patients; with the highest uptake seen in tumors of epithelial origin, including metastatic vaginal, ovarian and colon carcinomas, and liposarcoma, consistent with anti-P-cadherin targeting.

CONCLUSION

FF-21101 exhibits favorable biodistribution and dosimetry, enhancing its attractiveness as an imaging and therapeutic agent targeting P-cadherin overexpression.

CLINICAL RELEVANCE/APPLICATION

FF-21101 demonstrates P-cadherin targeting and favorable biodistribution, and thus may be a viable radioimmunotherapeutic agent for P-cadherin-overexpressing cancers.

SSK15

Neuroradiology (Striking at the Heart of Stroke)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: N226

ER MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSK15-01 Prediction of Malignant Cerebellar Edema Occurrence and Clinical Outcome after Ischemic Cerebellar Stroke Using Multiparametric CT

Participants
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PURPOSE

Malignant cerebellar edema (MCE) is a life-threatening complication after acute cerebellar stroke. The aim of this study was to identify imaging predictors for the occurrence of MCE using multiparametric CT including whole-brain CT perfusion (WB-CTP).

METHOD AND MATERIALS

We selected all subjects with cerebellar WB-CTP perfusion deficit and follow-up-confirmed infarction from a cohort of 3,254 consecutive patients who underwent multiparametric CT. Follow-up imaging was assessed for the presence (MCE+) or absence (MCE-) of MCE, measured using an established 10-point scale by Jauss et al., of which scores >=4 are considered malignant. Posterior-circulation-Acute-Stroke-Prognosis-Early-CT-Score (pc-ASPECTS) was determined to assess ischemic changes on non-contrast CT (NCCT), CT angiography (CTA), and on parametric WB-CTP maps (cerebral blood flow, CBF; cerebral blood volume, CBV; mean transit time, MTT; time to drain, TTD). The volumes of CBF, CBV, MTT, and TTD deficits were quantified. Chi-square, Mann-Whitney-U tests and receiver operating characteristics (ROC) analyses were performed.

RESULTS

Fifty-one patients were included. 42 patients (82.4%) were categorized as MCE- and 9 (17.6%) as MCE+. MCE+ patients had larger CBF, CBV, MTT and TTD deficit volumes (each with $p<0.001$) and showed significantly lower median pc-ASPECTS assessed using WB-CTP (CBF: 5 vs. 8; CBV: 8 vs. 9; MTT: 5 vs. 8; TTD: 5 vs. 8; each with $p<0.001$) compared to MCE- patients, while median pc-ASPECTS on NCCT was not significantly different (9 vs. 10, $p=0.097$). ROC analyses for MCE yielded the largest area-under-the-curve (AUC) values for CBF (0.984), followed by CBV deficit volumes (0.972) and pc-ASPECTS on CBF (0.949), whereas pc-ASPECTS on NCCT (0.664) and CTA (0.699) provided less diagnostic value. Regarding mortality, ROC analyses revealed the highest AUC values for pc-ASPECTS CBV (0.853) and CBV deficit volume (0.837), and the lowest AUC values for pc-ASPECTS on NCCT (0.610) and CTA (0.643).

CONCLUSION

WB-CTP provides added diagnostic value regarding the prognosis of MCE occurrence and clinical outcome after cerebellar stroke compared to NCCT and CTA.

CLINICAL RELEVANCE/APPLICATION

WB-CTP performed in acute cerebellar stroke has the potential to impact clinical decision making based on an early identification of patients that are at high risk of developing MCE.

SSK15-02 Utility of Serial and Ancillary Neuroimaging in Assessment of Suspected Hypertensive Hemorrhage

Wednesday, Nov. 29 10:40AM - 10:50AM Room: N226

Participants
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PURPOSE

To assess the utility of serial and ancillary neuroimaging in the work-up of primary intracerebral hemorrhage involving characteristic hypertensive regions, including basal ganglia, thalamic, pontine and cerebellar hemorrhages. Lobar hemorrhages were included in the study, although these are more classically seen with cerebral amyloid angiopathy in non-hypertensive patients.

METHOD AND MATERIALS

This IRB-approved study retrospectively reviewed hypertensive patients presenting to the emergency room or transferred from an outside facility with imaging findings of primary intracerebral hemorrhage from October 2013 - October 2015. Patients were excluded if they had known CNS malignancy. Age, admitting systolic blood pressure, the location of bleed, and findings from follow-up imaging were recorded.

RESULTS

A total of 135 patients were identified, of which 73.6% (98/135) and 51.9% (70/135) had follow-up CTA/MRA or MRI, respectively. Sites of involvement included basal ganglia (42.9%, 56), thalamic (24.4%, 36), lobar (20%, 27), and the remaining within the brainstem or cerebellum. Of patients who underwent ancillary imaging, CTA/MRA revealed a vascular abnormality in a single patient, an arteriovenous malformation within the cerebellum. MRI also revealed a vascular abnormality in a single patient, vasculitis resulting in lobar hemorrhage. All remaining follow-up imaging reviewed was negative for additional pathology. With regards to location, all cases of basal ganglia and thalamic hemorrhages were consistent with hypertensive hemorrhage only.

CONCLUSION

In the setting of hypertension, ancillary imaging for basal ganglia and thalamic hemorrhages did not reveal alternative etiologies. In the absence of initial findings to warrant operative management, serial CT imaging in otherwise clinically stable patients did not result in findings warranting a change in management.

CLINICAL RELEVANCE/APPLICATION

In the absence of clinical concerns and findings on initial imaging, there is low utility in ancillary and serial neuroimaging for primary intracerebral hemorrhage involving the basal ganglia and thalamus in patients presenting with hypertension.

SSK15-03 The Ischemic Penumbra Assessment Using 3D ASL at Different Post Labeling Delays in Patients with Unilateral Middle Cerebral Artery Severe Stenosis or Occlusion

Wednesday, Nov. 29 10:50AM - 11:00AM Room: N226

Participants
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PURPOSE

To evaluate ischemic penumbra (IP) using three-dimensional pseudo continuous arterial spin labeling (3D pCASL) at PLD of 1.5 s and 2.5 s in patients with ischemic cerebrovascular disease.

METHOD AND MATERIALS

Twenty-six patients (mean age, 60±12 years; 16 men and 10 females) with unilateral middle cerebral artery (MCA) severe stenosis or occlusion were enrolled into the present study, underwent MRI scan especially 3D pCASL with PLDs of 1.5s and 2.5s and DWI. The IP was first observed according to mismatched CBF-DWI region. The mean CBF (CBF1.5 vs. CBF2.5, mL/100g per minute) values and the mean area (mm2) of IP were measured at PLDs of 1.5s and 2.5s. Comparisons of the mean CBF values and the mean IP area between the two PLDs were analyzed using paired T test. Compared with the positive detection rate of IP by Chi-square test.

RESULTS

The detection rate of IP increased at the PLD of 1.5s (21/26, 80.77%) than 2.5s (6/26, 23.08%) (P=0.000). The mean CBF1.5 and CBF2.5 values of IP were 12.32±1.66 vs.18.84±1.44 (P=0.002). The mean IP area was also significantly widened at the PLD of 1.5s (4273.17±611.17) than 2.5s (1074.50±955.32, P=0.01).

CONCLUSION

IP detection and areas result from different PLD using 3D ASL and DWI in patients with ischemic cerebrovascular disease. The higher detection, decreased CBF and wider region of IP are present at the PLD of 1.5s.

CLINICAL RELEVANCE/APPLICATION

It is necessary to consider the different PLDs to assess IP by 3D pCASL in ischemic cerebrovascular disease.

SSK15-04 Early Identification of Tissue at Risk of Infarction after Acute Ischemic Stroke Using Convolutional Neural Networks

Wednesday, Nov. 29 11:00AM - 11:10AM Room: N226

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

Early identification of potentially salvageable tissue after acute ischemic stroke (AIS) is increasingly being used to guide treatment decisions. Deep learning algorithms, e.g. convolutional neural networks (CNN), have been employed for chronic stroke lesion segmentation. We investigated the utility of CNN algorithms for predicting tissue infarction on follow-up MRI based on acute DWI and PWI MRI.

METHOD AND MATERIALS

The study included 50 AIS patients not treated with reperfusion therapy with DWI and PWI acquired <12h from the time when patients were last known to be well. Patients were also required to have follow-up (F/U) imaging performed >= 4 days after stroke. Apparent diffusion coefficient maps, T2WI, isotropic DWI, MTT, and Tmax were used as covariates to train a CNN (5-fold cross validation). The CNN was trained via the open source framework DeepMedic using the default architecture. The CNN segmentation maps were evaluated for each patient individually. Performance metrics were based on Dice score, sensitivity, and precision.

RESULTS

The CNN prediction of F/U lesions resulted in a mean±SD Dice score of 42%±26%, sensitivity 39%±27% and precision 60%±30%. The CNN resulted in fair results for lesion volumes >= 10ml, however it underperformed for smaller lesions <10 mL (Dice score 24%±20%, Sensitivity 25%±25%, Precision 38%±30%). Visual inspection showed compelling results for large lesions (Figure). The lesion size group analysis and the correlations of lesion volumes revealed that performance was dependent on lesion extent.

CONCLUSION

Our results showed that CNN can be used to combine acute multiparametric MRI for predicting tissue infarction on F/U, which hold especially true for large lesions. Although the CNN performed best for large lesion volumes, the focus of many early decision-making for AIS patients is whether or not the patient is at high risk of infarct growth. Therefore, CNN algorithms that can identify which patients will experience large infarct volumes without intervention hold promise for guiding AIS treatment decision strategies on an individual patient basis.

CLINICAL RELEVANCE/APPLICATION

Convolutional neural networks can be used to combine acute multiparametric MRI to predict follow-up tissue infarction with high accuracy, and therefore has potential for guiding treatment decisions on an individual patient basis.

SSK15-05 Regional Detection of Hemorrhagic Transformation using Kernel Spectral Regression and a Neural Network on Multi-modal MRI for Acute Ischemic Stroke

Wednesday, Nov. 29 11:10AM - 11:20AM Room: N226

Participants
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PURPOSE

Hyperperfusion detected on arterial spin labeling (ASL) cerebral blood flow (CBF) images acquired after acute ischemic stroke (AIS) onset has been shown to be significantly associated with development of intracerebral hemorrhage. The purpose of this study was to develop a machine model for the voxel-based detection of tissue at risk for hemorrhagic transformation (HT) given multiple MRI modalities as input.

METHOD AND MATERIALS

The present study utilized routine clinical MRI and ASL image data acquired from 67 AIS patients shortly after endovascular therapy or clot retrieval. A novel regional cuboid sampling framework was developed for machine learning training, in which local cuboids were extracted from the CBF map, DWI, FLAIR, and T2 TSE before being matched with GRE-based manually drawn bleed groundtruth delineations. Kernel spectral regression (KSR) uses the information in the eigenvectors of the graph representation to reveal low dimensional structure in high dimensional data. After determining optimal kernel input parameters with KSR, we built a two-layer feed-forward neural network with 10 neurons in the sigmoid hidden layer and trained with scaled conjugate gradient backpropagation to classify cuboid inputs into likelihood of HT.

RESULTS

The proposed multimodal regional framework reached an accuracy of 80.59 ± 3% in detecting hemorrhage with KSR on our dataset (better than any single image modality alone); while a simple voxel-based prediction was 72.80 ± 5% accurate. Using the neural network training, the framework reached an improved accuracy of 95.1% ± 0.6%. Figure 1 shows a few predictive images based on the probabilities determined by the neural network. One can appreciate how the regions with high likelihood of hemorrhage determined by machine learning match well with the manually drawn regions in the reference GRE map.

CONCLUSION

Machine learning using kernel spectral regression or neural networks in particular can provide more accurate detection of tissues at risk for HT. Although CBF can inform AIS patient clinical outcome, the addition of multi-modal MRI data into the regional cuboid framework substantially improves the voxel-based HT detection accuracy.

CLINICAL RELEVANCE/APPLICATION

The proposed multi-modal regional framework for HT detection can improve stroke physicians' utilization of perfusion data in AIS treatment planning and monitoring.

SSK15-06 The Detectability of Forward Projected Model-Based Iterative Reconstruction for Low Contrast Lesions: Acute Cerebral Infarction-Phantom Study

Wednesday, Nov. 29 11:20AM - 11:30AM Room: N226

Participants
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PURPOSE

Low-contrast areas in acute cerebral infarction are often difficult to be detected by computed tomography (CT) despite use of hybrid iterative reconstruction techniques such as adaptive iterative dose reduction 3D (AIDR 3D, Toshiba Medical Systems). Forward projected model-based Iterative Reconstruction SoluTion (FIRST, Toshiba Medical Systems), a novel iterative reconstruction technique, can strongly reduce noise and beam hardening artifact and improve spatial resolution. We compared the detectability of low contrast lesions on AIDR 3D- and FIRST images using a head phantom including simulated acute cerebral infarction.

METHOD AND MATERIALS

We developed dedicated head phantoms including simulated acute cerebral infarction using a 3D printer (Agilista 3200, Keyence). This study included 36 images of various models of acute cerebral infarction and 24 images of normal brain model. Half of these images were reconstructed with AIDR 3D and the rest were reconstructed with FIRST. Two radiologists separately specified the location of the low-contrast lesions in which subtle contrast between the gray and white matter diappeared. They rated the probability of the presence using an analog confidence scale. For the evaluation ROC analysis was performed. Statistical difference between AIDR 3D and FIRST was tested by DeLong's method.

RESULTS

ROC analysis showed that the difference between AIDR 3D (reader1: Az- value 0.773, reader2: Az- value 0.706) and FIRST (reader1: Az- value 0.935, reader2: Az- value 0.880) was significant in favour of FIRST (p = 0.037, 0.041, respectively).

CONCLUSION

Our study demonstrates a significant advantage of FIRST in the detection of low contrast lesions compared with AIDR 3D, one of the conventional iterative reconstruction techniques.

CLINICAL RELEVANCE/APPLICATION

FIRST may improve detectability of low contrast lesions in acute cerebral infarction.

SSK15-07 Intra-Arterial Thrombectomy in Patients with Cervical Dissections in the MR CLEAN Trial: A Descriptive Analysis

Wednesday, Nov. 29 11:30AM - 11:40AM Room: N226

Participants
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PURPOSE

Several treatment strategies have been proposed in patients presenting with acute stroke and an extracranial dissection of the internal carotid artery (ICA). The aim of this study is to describe the outcome and variation of treatment strategies in intra-arterial thrombectomy (IAT) in patients with dissection of extracranial ICA and a proximal intracranial occlusion.

METHOD AND MATERIALS

Data (n=500) of the randomized controlled MR CLEAN trial on the effectiveness of IAT were analyzed. Carotid dissection was identified on CTA scans at baseline. Primary outcome was a favorable functional outcome defined as an modified Rankin Scale (mRS) score of <=2. Secondary outcomes were mRS <=3 and serious adverse events (SAE).

RESULTS

Carotid dissection was identified in 24 patients (21 male; median age 50.5)of which 15 in IAT group and 9 in non-IAT group. No differences at baseline NIHSS (p 0.74) and collateral score (p 0.29) was observed. In two patients stent placement was performed during IAT. A good functional outcome was observed at 7 (47%) in the IAT group versus 1 patient (11%) but was not statistically different (p 0.18). With respect to secondary outcomes, mRS <=3 and SAE were significantly different in favor of IAT (resp. p 0.03 and 0.04).

CONCLUSION

IAT is feasible in patients with extracranial dissections of the ICA and good outcomes have also been observed without carotid stenting.

CLINICAL RELEVANCE/APPLICATION

Carotid dissection is not a reason the withhold IAT in acute stroke patients.

SSK15-08 Diagnostic Accuracy of 3D black blood MRI with High Resolution T1 SPACE in the Evaluation of Intracranial Arterial Thrombosis

Wednesday, Nov. 29 11:40AM - 11:50AM Room: N226

Participants
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PURPOSE

3D black blood (BB) MRI using a T1 sampling perfection with application-optimized contrast using different flip angle evolutions (SPACE) sequence allows high resolution, vessel wall imaging to evaluate the intracranial arterial wall and its associated pathologies. We investigated the diagnostic features and accuracy of 3D BB MRI in the detection of arterial thrombosis.

METHOD AND MATERIALS

We retrospectively identified fifteen patients with intracranial arterial thrombosis that underwent 3D BBMRI with non-enhanced and contrast enhanced high resolution T1 SPACE sequences. 3D BBMRI findings were evaluated by 2 independent neuro-radiologists blinded to all other angiographic studies, conventional MRI sequences, and clinical indications for imaging. Nineteen total intracranial vessel segments per patient were evaluated and graded on a three-point scale (grade 0-2) [Table] for intraluminal TI SPACE hyperintensity and contrast enhancement. Images were considered positive for arterial thrombosis when focal intraluminal T1 SPACE hyper-intense signal and/or enhancement on 3D BBMRI was graded as 1 or 2. Arterial occlusion was confirmed by digital subtraction angiography (DSA) or computed tomographic angiography (CTA). In limited cases (n=4) without DSA/CTA availability, susceptibility weighted imaging (SWI) in combination with time of flight (TOF) MR angiography (MRA) confirmed the diagnosis of complete vessel occlusion.

RESULTS

Fifteen patients with 18 intracranial arterial occlusions were studied. Fair inter-observer agreement for intraluminal T1 SPACE hyperintensity (Kappa = 0.50) and excellent inter-observer agreement for contrast enhancement (Kappa = 0.84) was noted. The sensitivity and specificity for intracranial arterial thrombosis of intraluminal T1 hyperintensity was 88.89% and 100% respectively and that of contrast enhancement was 94.45% and 100% respectively, taking Observer 1 as gold standard and Observer 2 as test when both partial and clear visualization (combined grades 1 and 2) suggested vessel thrombosis/occlusion.

CONCLUSION

3D BBMRI with T1 SPACE imaging is a valuable sensitive and specific technique for the evaluation of intracranial arterial thrombosis.

CLINICAL RELEVANCE/APPLICATION

This technique provides an adjunctive mechanism to confidently diagnose complete arterial occlusions in the setting of low resolution conventional MRI findings and absent flow enhancement on TOF-MRA imaging prone to overestimation.

SSK15-09 Actionable Vascular and Other Incidental Findings on CTA in Patients Undergoing Acute Stroke Intervention: Findings in 225 Patients

Wednesday, Nov. 29 11:50AM - 12:00PM Room: N226

Participants
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PURPOSE

The detection and appropriate management of incidental findings is an important part of any clinical radiology practice. The intricate anatomy covered by CTAs of the head and neck coupled with the time pressures of acute stroke diagnosis creates an environment for missing important unrelated findings. The purpose of our study was to document incidental findings on CTA in 225 patients undergoing acute stroke intervention.

METHOD AND MATERIALS

Under IRB approval and HIPAA compliance, 225 CTAs of the head and neck in patients undergoing acute stroke intervention from 2011-2016 were reviewed for important incidental findings. Average patient age was 65 (range 16-95 years). Findings were separated into vascular (mainly aneurysms) and non-vascular entities (such as tumor and infection), with results tabulated.

RESULTS

There were 19 vascular and 31 non-vascular important incidental findings. Intracranial aneurysms were the most common vascular finding, with 18 aneurysms present in 16 patients (7% of patients). All aneurysms were unknown prior to imaging, with average size of 5mm(range of 2-10mm). 5 malignancies, most of which were unknown, included 2 lung cancers and an erosive nasopharyngeal skull base tumor. 2 patients with malignancy had pathologic cervical spine fractures. Critical pulmonary findings included 3 malpositioned endotracheal tubes in their right main stem bronchus, and 1 moderate pneumothorax. 6 patients had pulmonary edema, and 3 had pneumonia.

CONCLUSION

Providing fast and accurate diagnosis of acute large vessel occlusion on CTA is essential for good stroke outcomes. However, important and even urgent findings are surprisingly frequent in this patient population, and should be looked for with equal fervor.

CLINICAL RELEVANCE/APPLICATION

CTAs of the head and neck in patients undergoing acute stroke intervention harbor important and urgent findings with surprising frequency, and should not be overlooked even in this time-sensitive clinical scenario.

SSK16

Neuroradiology (Epilepsy Imaging: Finding the Spark)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: N229

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Girish M. Fatterpekar, MBBS, New York, NY (*Moderator*) Nothing to Disclose
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Sub-Events

SSK16-01 Comparison of Arterial Spin Labeling MRI With EEG and Structural MRI in Patients With Epilepsy

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The purpose of our study was to compare the results of interictal EEG and structural MRI with ASL-MRI findings in patients with epilepsy in the peri-ictal period and inter-ictal period and try to localize the epileptogenic zone.

METHOD AND MATERIALS

Two groups of patients were selected. The first group consisted of 21 patients having seizure episode in the hospital premises (selected randomly as per availability of MRI machine at time of seizure) who underwent structural MRI with an additional ASL sequence in the peri-ictal period (arbitrarily fixed at 2 hours from seizure onset). The patients also underwent an inter-ictal scalp EEG. The second group included 30 patients with refractory seizures who underwent inter-ictal structural MRI with additional ASL sequence (selected randomly from out-patient referrals for MRI from a dedicated seizure clinic). Inter-ictal scalp EEG was also performed for these patients. Hyperperfusion or hypoperfusion was recorded and localized to the hemisphere and if possible the anatomical lobe.

RESULTS

In the 'peri-ictal' group, 'structural MRI positive' patients had 87.5% concordance of ASL findings with the structural MRI abnormalities (50% showed localization to ipsilateral hemisphere -partial concordance, and an additional 37.5% to ipsilateral lobe and the hemisphere -complete concordance) whereas the 'structural MRI negative' patients had 71.3% concordance between ASL and structural MRI findings (57% having complete concordance and an additional 14.3% showing partial concordance). In the 'inter-ictal' group, 'structural MRI positive' patients showed 75% concordance between ASL and structural MRI findings (50% complete concordance and 25% partial concordance) and 'structural MRI negative' patients had a 78.5% concordance between ASL and structural MRI findings (71.4% complete concordance and additional 7.1% partial concordance).

CONCLUSION

Perfusion abnormalities are intricately linked with seizures in both inter-ictal and peri-ictal phase with localized hyperperfusion being the most frequent pattern in peri-ictal and hypoperfusion predominating in the inter-ictal phase.

CLINICAL RELEVANCE/APPLICATION

ASL imaging can be a promising complementary imaging tool and can be contributory to the clinical scenario irrespective of the time of imaging, including in follow-up imaging and in increasing confidence in lesion localization for possible surgical work-up.

SSK16-02 Multi-Regional Volumetric Patterns are Associated with Post-Surgical Outcomes in Patients with Medically Refractory Temporal Lobe Epilepsy

Wednesday, Nov. 29 10:40AM - 10:50AM Room: N229

Participants
Anil K. Vasireddi, BS,MD, Pittsburgh, PA (*Presenter*) Nothing to Disclose
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PURPOSE

To investigate patterns of regional pre-operative volumetric differences that may be associated with post-operative outcome using lasso regression analysis (LRA) in patients with medically refractory temporal lobe epilepsy (TLE) who underwent anterior temporal lobectomy (ATL).

METHOD AND MATERIALS

69 subjects with TLE treated with ATL are classified as either seizure-free (ILAE 1-2) or as having continued seizures (ILAE 3-6) postoperatively. Preoperative T1-weighted MRI were analyzed for volumetric measurements. LRA was performed to identify groups of regions associated with postoperative outcomes and results were cross-validated to quantify the selected model's ability to predict outcome classification. A sub-group of patients with pathology proven mesial temporal sclerosis (MTS) was analyzed in a similar manner (n=26).

RESULTS

LRA identified smaller volumes in the contralateral occipital lobe as being associated with the seizure-free group ($p = 0.0179$); cross-validation revealed sensitivity of 0.27 and specificity of 0.77 in correctly identifying patients with continued postoperative seizures. In the sub-group of patients with MTS, LRA selected the contralateral occipital lobe, ipsilateral hippocampus, ipsilateral caudate, contralateral cerebellum, and contralateral frontal lobe in the model associated with postoperative outcomes ($p<0.001$). Cross-validation yielded better results in the more focused sub-group (sensitivity = 0.7, specificity=0.81). Hippocampal volumes alone were not significantly different between the seizure-free and continued seizures groups in either analysis.

CONCLUSION

LRA identified temporal and extra-temporal regions associated with postoperative seizure outcome. The model selected by LRA was more descriptive and more robust in cross-validation when limited to subjects identified by a single pathology such as MTS indicating that the underlying pathology should be accounted for in such analyses. Involvement of extra-temporal regions may be related to extra-temporal seizure activity, chronic sequela of anti-epileptic drug usage and/or history of frequency/severity and generalization of seizures.

CLINICAL RELEVANCE/APPLICATION

Approximately 40% of patients who undergo temporal lobectomy for TLE may continue to experience seizures postoperatively. Thus, further stratification of potential surgical candidates using pre-operative data may improve outcomes.

SSK16-03 The Clinical Impact of Emergency CT Brain Scan in Seizure

Wednesday, Nov. 29 10:50AM - 11:00AM Room: N229

Participants
Bodo P. Kress, MD, Frankfurt, Germany (*Presenter*) Research Grant, Guerbet SA; Research Grant, Bayer AG
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PURPOSE

Does emergency CT brain in patients with seizures have an immediate clinical impact?

METHOD AND MATERIALS

In a retrospective analysis we evaluated 1785 CT brain scans performed between 2006 and 2013 in patients after seizures. The indication for this exam has been to exclude pathological lesions being focus of seizures or being caused by seizures. Study design and protocol has been approved by our local ethic comitee (S071/2017).

RESULTS

1088 male, 697 female, average age 58 years. In 173 (9,6%) patients the CT scan revealed a significant pathological finding. In 104 (5%) patients a either tumorous or metastatic lesion was found, in 62 (3,5%) hemorrhages (subdural, epidural, parenchymal or subarachnoidal) and in 14 (0,7%) signs of a subacute infarct. 1 patient revealed signs of a acute hydrocephalus. All patients with infarcts were outside the lysis time window or time window for thrombectomy. No patient with tumorous or metastatic lesion needed immediate treatment. 6 (0,3%) of 62 patient with hemorrhage were transfered for immediate treatment. All 6 patients had clinical symptoms additionally to seizures such as clinical history of acute headache, midface fracture, hypertension (>220mmHg). No patient with isolated clinical symptom of seizure needed emergency treatment.

CONCLUSION

In this study no CT scan revealed pathological findings with immediate clinical impact if patient had only clinical history of seizure. It should be discussed whether patient with additional clinical symptoms such as acute headache, severe head trauma or hypertension need CT scan in the acute setting and whether the other patients -taken to the ward for surveillance- are evaluated only by MR scan in between 24 hours.

CLINICAL RELEVANCE/APPLICATION

Retrospective design is ia limitation, however all other studies published in the literature evaluated less than 200 exams (while we evaluated 1785), therefore this is the study with by far the biggest number of cases.

SSK16-04 Abnormality of Cerebral White Matter Microstructure in Children with New-Onset, Untreated Idiopathic Generalized Epilepsy

Wednesday, Nov. 29 11:00AM - 11:10AM Room: N229

Participants
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Lizhou Chen, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Epilepsy, as one of the most prevalent, noncommunicable neurologic conditions and a significant cause of disability and mortality, affects approximately 70 million people worldwide. Microstructural change of idiopathic generalized epilepsies (IGE) has been widely reported in children and adult patients. However, previous studies were focused on the chronic patients with antiepileptic drugs. This study aims at using the diffusion tensor imaging (DTI) technique to investigate the microstructural abnormalities of white matter in children with new-onset, untreated IGE.

METHOD AND MATERIALS

A total of 45 IGE patients (age range: 5-18 years, males: females=26:19) and 32 healthy controls (age range: 5-18 years, males: females=21:11) were included in our present study. Voxel-based analysis was used to compare the differences of DTI metrics including fractional anisotropy (FA) and mean diffusivity (MD) between patients and controls. Pearson correlation analysis was used to investigate the relationships between altered DTI metrics and clinical parameters.

RESULTS

After multiple comparison correction using family-wise error method, only the parameter of mean diffusivity (MD) showed significant decrease in the left paracentral lobule, right precuneus and right superior parietal lobule (SPL) in IGE patients compared to healthy controls. Increased factional anisotropy (FA) was found in the deep white matter of bilateral prefrontal lobe in IGE patients at a less conservative level using AlphaSim correction. There was no correlation between the altered diffusion parameters and the clinical measures.

CONCLUSION

Our study demonstrated microstructural impairments in children with new-onset, untreated IGE and that the MD might be more sensitive to detect the microstructural changes in the early stage of IGE than FA. Furthermore, the increased FA and decreased MD in the IGE group might suggest an initiating or compensatory mechanism prior to cognitive decline in IGE patients. Longitudinal studies are needed to clarify the maturational and seizure-related nature of these alterations of brain anatomy, their potential progression over the course of illness in IGE patients, and the potential impact of therapeutic intervention on these processes.

CLINICAL RELEVANCE/APPLICATION

Microstructural abnormalities exist from the very beginning of IGE and MD may be more affected than FA in the initial stage of children with IGE.

SSK16-05 Utility of MRI Brain Epilepsy Protocol in New Onset Seizures: How is it Different in Developing Countries?

Wednesday, Nov. 29 11:10AM - 11:20AM Room: N229

Participants
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PURPOSE

1. To evaluate the diagnostic efficacy of a standard MRI of the brain in patients with first onset seizures. 2. To identify whether there is an increase in the diagnostic yield with the addition of high-resolution sequences with a dedicated seizure protocol. 3. To compare the diagnostic yields of MRI and EEG individually and in combination.

METHOD AND MATERIALS

Patients presenting with a history of first onset seizures who underwent MRI of the brain and EEG. Totally 129 cases were studied for a period of 18 months. Chi square test of significance ($p<0.005$) was used to test for the difference in proportion. The correlation between MRI brain and EEG was studied using McNemer test. All the patients underwent both standard protocol and dedicated epilepsy protocol MRI brain scanning on 1.5T within seven days from the onset of seizures. A routine electroencephalogram is recorded from the scalp electrodes obtained three days before or after the MRI and as soon as practical after presentation with the index seizure, preferably within 48 hours.

RESULTS

The diagnostic yield of MRI in detecting epileptogenic lesion was 47% in our study. Among the potentially epileptogenic lesion, infection and inflammation was most common 17 (28%). Of the 59 patients with potential epileptogenic lesions in our study, 37 (63%) epileptogenic lesions were detected using "standard protocol" MRI and remaining 22 (37%) lesions were detected using "dedicated epilepsy protocol" MRI. Of the epileptogenic lesions, all 11 patients (100%) with hippocampal sclerosis were detected by using "epilepsy protocol" MRI which would have been missed if only "standard protocol" MRI was done. Patients who presented with focal-onset seizures (27) had a higher proportion of potentially epileptogenic lesions 22 (81%) compared with the patients with generalized clonic tonic seizures. There were 22 patients (18%) with an abnormality on both MRI and EEG. So, abnormal MRI and

EEG were concordant in18% of patients in our study.

CONCLUSION

A dedicated epilepsy protocol MRI should be done in all patients who presents with first-onset seizures. MRI in first-onset seizure patients allows the identification of a lesion and earlier consideration of epilepsy surgery especially in patients presenting with focal-onset seizures.

CLINICAL RELEVANCE/APPLICATION

A dedicated epilepsy protocol MRI should be done in all patients who presents with first-onset seizures.

SSK16-06 PET-MRI Value in Detecting 'Occult' Anterior-Inferior Temporal Lobe Encephaloceles in Medically Refractory Focal Temporal Lobe Epilepsy

Wednesday, Nov. 29 11:20AM - 11:30AM Room: N229

Participants
Karl N. Krecke, MD, Rochester, MN (*Presenter*) Nothing to Disclose
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PURPOSE

Temporal lobe anterior-inferior encephaloceles are increasingly recognized as a surgically amenable cause of adult medically-refractory temporal lobe epilepsy. The anatomic defect on MRI exam can be quite subtle and these lesions are frequently overlooked for multiple years and exams. Two such cases led to a review of our PET-MRI experience in imaging-occult medically refractory focal epilepsy.

METHOD AND MATERIALS

PET-MRI has been part of our epilepsy imaging armament since December 2015. A PET-MRI database was created that included patients with refractory focal epilepsy that were considered non-lesional, based on prior MRI exams. The PET-MRI exams were reviewed without knowledge of the specific clinical history or signs and symptoms with a goal of identifying additional cases of anterior inferior temporal lobe encephalocele. Separately, we collected demographic and clinical data from the medical record including age of seizure onset, semiology, EEG and interpretation of prior imaging exams.

RESULTS

Sixty-eight patients were catalogued in our epilepsy PET-MRI database including examinations through March 31, 2017. Four patients were identified with anterior-inferior temporal lobe encepahlocele. Two patients had been identified through clinical evaluation for epilepsy surgery and two additional patients were identified though this retrospective review. The key PET-MRI findings were 1. Decreased FDG uptake in anterior temporal lobe, ipsilateral to the clinical region of concern, 2. FDG activity extending beyond the expected confines of the middle cranial fossa and sphenoid wing, 3. MRI findings of CSF or brain extending into a defect in sphenoid wing, unrecognized on prior exams. Demographic items include: 3 female patients (75%), age: mn= 28 (15-43 range), age from seizure onset mn=9 years (3-18 range). The three female patients demonstrated MRI findings of incranial hypertension or dural ectasia.

CONCLUSION

PET-MRI can be useful as a next-step in evaluation of medically refractory focal temporal lobe epilepsy, particularly in the surgical candidate. Anterior-inferior temporal lobe encephalocele, as a cause of refractory epilepsy, is unusual but a combination of co-localizable findings can identify patients who may benefit from a focal resection.

CLINICAL RELEVANCE/APPLICATION

Temporal lobe encephalocele is emerging as an important, surgically amenable cause of epilepsy. PET-MRI can help with detection.

SSK16-07 Hippocampal Sclerosis with Negative MR Findings: Diagnostic Usefulness of Subfield Volumetric Analysis

Wednesday, Nov. 29 11:30AM - 11:40AM Room: N229

Participants
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PURPOSE

In previous studies, up to 15% of the patients with diagnosis of hippocampal sclerosis (HS) showed normal findings on conventional MRI (neg-MR). Recently, subfield volumetry of hippocampus (SVH) using the open-source automatic segmentation software has been utilized. Our aims were; (a) to study the volume changes of the hippocampal subfields in HS patients using SVH, and (b) to determine the diagnostic accuracy of the SVH for the HS patients with neg-MR.

METHOD AND MATERIALS

We assessed 46 unilateral HS patients and 54 controls; all HS cases had histopathologic confirmation by surgery. Two neuroradiologists divided the HS patients into two groups based on the presence (pos-MR, n=26) or absence (neg-MR, n=20) of following MR findings at the affected hippocampus; reduced volume or increased T2 signal. For SVH analysis, 3D-volume T1-weighted images were processed with FreeSurfer (ver.5.3, ver.6.0) in all patients and controls. The ratio to total intracranial volume were calculated for each subfield and compared among the two groups. The diagnostic accuracy (AUC) were calculated using cutoff values for the hippocampal subfield volumes that were obtained in a ROC analysis.

RESULTS

In the pos-MR group, 8 of 9 subfields at the affected side (CA1, CA3, CA4-DG, fimbria, hippocampal-amygdala transitional area, presubiculum, hippocampal tail, and subiculum) were significantly smaller than in the controls. In the neg-MR group, however, only 2 of 9 subfields (CA3 and CA4-DG) were significantly smaller than in the controls. The diagnostic accuracy of the discrimination of the HS patients with neg-MR was better for the SVH based on the volumes of CA3 and CA4-DG (AUC: 0.719) than for the volume of the whole hippocampus (AUC: 0.614).

CONCLUSION

In the MR-negative HS patients, the subfield volumetry detected the localized atrophy within CA3 and CA4-DG, and showed better diagnostic performance than the whole hippocampal volume.

CLINICAL RELEVANCE/APPLICATION

In the mesial temporal epilepsy patients with normal findings on conventional MRI, SVH may be used not only for the diagnosis of HS but also for the assessment of its histopathologic subtypes.

SSK16-08 Longitudinal Functional Connectivity of Language Networks in Surgical Epilepsy Patients: Preliminary Results

Wednesday, Nov. 29 11:40AM - 11:50AM Room: N229

Participants
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PURPOSE

Investigating the reorganization of language networks in temporal lobe epilepsy (TLE) patients with task-based functional MRI (fMRI) before and after selective amygdalohippocampectomy or anterior temporal lobectomy (ATLR).

METHOD AND MATERIALS

Eighteen TLE patients (8 left TLE, 10 right TLE) performed task-based fMRI using a verb generation and a semantic paradigm before and after neurosurgery (9 ATLR; mean age at surgery: 38y, range: 26-53y). Mean time between surgery and postoperative scan was 14.9 months (range: 3-44m). Neuropathology revealed hippocampal sclerosis in 13 patients, focal cortical dysplasia in 4 patients and ganglioglioma in one patient. Ten healthy right-handed subjects underwent the same fMRI protocol on the same 3T scanner (mean age: 38y, range: 31-49y). FMRI activation maps and functional connectivity (FC) were analyzed on SPM12 for intra- and intergroup comparisons ($p<0.005$ uncorr.).

RESULTS

Compared to controls, patients showed decreased FC ipsilateral to their epileptogenic focus before and after surgery. In comparison to scans before surgery, postoperative left TLE patients had markedly decreased FC involving the left TL with particularly less connections to the right frontal lobe, stronger connections were visible including the residual left posterior TL and the right TL. In postsurgical right TLE, inter- and intrahemispheric FC to the right TL was decreased with only few stronger postsurgical connections exclusively found in the left hemisphere.

CONCLUSION

Task-based fMRI functional connectivity analysis visualizes extensive language related reorganization processes in TLE patients following surgery. Patterns of reorganization in language FC differ between left- and right-sided TLE with more extensive changes in left TLE patients.

CLINICAL RELEVANCE/APPLICATION

Temporal lobe epilepsy (TLE) surgery triggers widespread changes of language-related functional connectivity (FC). FC analysis allows us to link specific clinical deficits with certain neuroanatomical and imaging substrates. This will help to optimize surgical approaches and minimize postoperative language deficits in individual TLE patients.

SSK16-09 DTI-Derived Textural Features Can Improve Detectability of Epileptogenic Tubers in Tuberous Sclerosis Complex

Wednesday, Nov. 29 11:50AM - 12:00PM Room: N229

Participants
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Yoko Hirata, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
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Noriko Salamon, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Diffusion tensor imaging (DTI)-derived quantitative values such as maximum apparent diffusion coefficient (ADC) were reported as predictors of epileptogenic tubers in tuberous sclerosis complex (TSC). Texture of tubers, volume and location were also known predictors of epileptogenicity. The purpose of this study was to document detectability of texture analysis for DTI, which can combine the information of DTI and textural heterogeneity.

METHOD AND MATERIALS

Twenty-five consecutive studies involving 23 patients were involved in this study. Epileptogenic tubers were characterized using video-encephalographyEEG, structural MRI, FDG-PET, magnetoencephalography, magnetic source imaging (MSI) and intraoperative electro-corticography. A total of 558 tubers, 32 epileptogenic and 526 nonepileptogenic, were identified. The volume of interest (VOI) of tubers was drawn on an ADC map based using T2-weighted and FLAIR images. The original VOI was inflated to include 4-mm-thick ring-shaped tissues surrounding the tuber. Histogram- and 3-dimentional 13-direction gray-level co-occurrence matrix (GLCM)-based textural features were extracted from the VOIs using ADC, fractional anisotropy, axial diffusivity and radial diffusivity maps. Mann-Whitney U-test with false discovery rate control was used to compare the features. The diagnostic model was constructed with an elastic net model to avoid overfitting. The model was compared with known predictors using receiver operating characteristic analysis and DeLong test.

RESULTS

A total of 122 features was derived from each VOI. There were no significant difference in features derived from the original VOI between epileptogenic vs non epileptogenic tubers. By contrast, 32 of 122 features showed significant differences on the inflated VOI. The diagnostic model was significantly better than the ROC curves of maximum ADC, volume and location (area under curve = 0.75 vs. 0.67 and 0.55; P = 0.042 and 0.001). The model did not significantly surpass tuber volume (0.75 vs. 0.71, P = 0.119).

CONCLUSION

Texture analysis using inflated VOI showed improved diagnostic performance to differentiate between epileptogenic and nonepileptogenic tubers. The VOI within the tuber was not useful for DTI-based texture analysis.

CLINICAL RELEVANCE/APPLICATION

DTI-derived texture analysis with VOI including perituber tissue can improve detectability of epileptogenic tubers in tuberous sclerosis complex.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSK17

Physics (MR: New Techniques, System Evaluation)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S404AB

MR PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Seth A. Smith, PhD, Nashville, TN (*Moderator*) Nothing to Disclose

Sub-Events

SSK17-01 Blipped Radial CAIPIRINHA for Simultaneous Multislice pseudo-SSFP Magnetic Resonance Fingerprinting

Participants
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Eric Paulson, PHD, Milwaukee, WI (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The purpose of the present work is to accelerate pseudo steady-state free-precession magnetic resonance fingerprinting (pSSFP-MRF) T1 and T2 mapping sequences with simultaneous multislice (SMS) imaging methods.

METHOD AND MATERIALS

Controlled aliasing (CAIPI) techniques are useful for improving the image quality from SMS acquisitions. For multi-shot non-Cartesian k-space trajectories, as is the case for most MRF acquisitions, CAIPI takes the form of modulating the phase of one or more SMS slices relative to the others from readout-to-readout. This is usually accomplished by means of RF phase cycling. An underlying assumption of the pSSFP-MRF method, however, is that all slices experience a sign change of RF phase in consecutive excitations, thus prohibiting the use of RF phase cycled CAIPI. Gradient blips along the slice-selection axis allow similar CAIPI phase modulation without the use of RF phase patterns. This work employs a blipped-CAIPI acquisition with a radial trajectory for pSSFP-MRF. The SMS pSSFP-MRF sequence was implemented on a Siemens 3T scanner. The gradient blips were applied to induce a phase difference of pi/2 between two simultaneously excited slices. The sign of the gradient blip changed in each subsequent spoke which rotates with the golden angle of ~111.246 degrees. A total of 881 spokes were acquired in approximately 5 seconds. To reconstruct images of each slice, the conjugate of the blip-induced phase of the slice-of-interest was added to each spoke. A dictionary was simulated, and T1 and T2 maps were reconstructed using the low rank (R=5) alternating direction method of multipliers (ADMM) technique. The brain of a glioblastoma patient who consented to be a part of an institutional review board approved study was scanned.

RESULTS

The T1 and T2 maps of two simultaneously excited slices are shown in the figure. Total acquisition time was 5 seconds. No slice-leakage is apparent. The relaxation times outside of the tumor agree with literature values for healthy brain tissue. Lengthened T1 and T2 values can be seen within the lesion.

CONCLUSION

A blipped radial CAIPI pSSFP-MRF sequence permits rapid T1 and T2 mapping for use in disease diagnosis, treatment planning, and response assessment.

CLINICAL RELEVANCE/APPLICATION

This work aims to further push the acceleration of pSSFP magnetic resonance fingerprinting scans to aid in the clinical adoption of fully quantitative imaging protocols.

SSK17-02 First Clinical Assessment of kT-Points Dynamic RF Shimming on Abdominal DCE-MRI in a Commercial 3T MRI Scanner

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S404AB

Participants
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PURPOSE

The 'B1 artefact' is an important challenge for abdominal MRI at 3T. Our aim was to assess excitation homogeneity and image quality achieved in the liver by kT-points pulses, compared to patient-tailored static RF-shimming.

METHOD AND MATERIALS

The prototypical non-selective kT-points pulse design was compared with patient-tailored static RF shimming for 3D breath-hold liver DCE-MRI on a product dual-transmit MAGNETOM Skyra MRI (Siemens Healthcare). 50 consecutive patients referred for liver MRI at a single institute were included in this IRB-approved study. Quantitative analysis was carried out via simulation to estimate flip angle homogeneity. Signal homogeneity, T1 contrast, enhancement quality, structure details and global degree of trust provided by each technique were qualitatively assessed on a 4-level scale (0 to 3) by 2 radiologists on in vivo pre-injection and late-phase images from 20 acquisitions selected from the pool. An exact matched-pairs one-tailed Wilcoxon signed-rank test was used to compare the methods.

RESULTS

Average excitation inhomogeneity was significantly reduced with kT-points compared to static RF-shimming (mean flip angle error ± standard deviation: 8.5±1.5% vs 20.4±9.8% respectively; $p<0.0001$). The worst case (heavy ascites) was 13.0% (kT-points) vs 54.9% (RF-shim). KT-points qualitative grades were higher for all criteria. Global image quality was significantly higher for kT-points than for RF-shimming (mean grade ± standard deviation: 2.3±0.5 vs 1.9±0.6; $p=0.008$). One subject's examination was judged unusable (0/3 for all criteria) with RF-shim by one reader and none with kT-points. 85% of kT-points acquisitions were graded at least 2/3, compared to only 55% in the static RF-shim case.

CONCLUSION

KT-points significantly reduce excitation inhomogeneity both quantitatively and qualitatively, especially in patients with ascites and prone to 'B1 artefact'.

CLINICAL RELEVANCE/APPLICATION

Proper excitation homogeneity is crucial to take advantage of the high signal-to-noise ratio available at 3T. KT-points improve 3T MRI for abdominal imaging of all patients.

SSK17-03 Multi-Compartmental Analysis Using a Fast Multi-Echo TSE Sequence for Prostate Cancer Diagnosis

Wednesday, Nov. 29 10:50AM - 11:00AM Room: S404AB

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PURPOSE

Prostate tissue has three major histological components: stroma, glandular lumen and epithelial cells. These volume fractions change when cancer is present. This study evaluates the feasibility of measuring the volume fractions of these compartments quantitatively in normal prostate and prostate cancer (PCa) using multi-compartment T2 decay modeling. A fast multi-echo TSE T2 MRI (k-t-T2) was applied to obtain high resolution T2 maps in clinically feasible scan time. Signal contributions from the three compartments were compared with pathological slices as a gold standard.

METHOD AND MATERIALS

k-t-T2 data were acquired on 17 patients on Philips 3T Achieva scanner; this method uses k-space under sampling for image acquisition to accelerate the scan. TR=3.1-10s; 32 echoes; ΔTE=12ms (TE=24-396ms); 1.0x1.0x3 mm3 in-plane resolution, scan time=4.5-9.6min. Regions of-interest (ROIs) including PCa (n=28) and normal prostate (n=43) were identified through histologic and MRI consensus review. Voxel-based three compartment analysis was used to extract the epithelial, lumen and stromal volume fractions, and T2 value of each compartment, in each ROI. Kruskall-Wallis test and Welch two sample t-test were used to evaluated the statistical significance between ROI groups. Spearman correlation coefficient was calculated between the image features and ROI-specific Gleason scores (GS).

RESULTS

ROI based analysis results showed the volume fraction of epithelium (50±12% vs. 37±10%) and lumen (11±6% vs. 21±7%) are

significantly different between PCa and normal prostate (p<0.01). There is no significant difference in stromal volume fraction (39±9% vs. 41±8%) between PCa and normal prostate (p>0.5). The volume fractions measured by MRI are close to those reported in previous histological studies. The volume fractions of epithelial cells and lumen are strongly correlated with GS (ρ =0.53; -0.41, p<0.05). Epithelial volume fraction in PCa correlates better with GS compared to T2 values (ρ=-0.41, p=0.02).

CONCLUSION

Multi-echo k-t-T2 sequence is feasible in clinical setting. Volume fractions obtained from three compartment model fitting of spin echo signal decay sampled at multiple TE's may help to characterize prostate lesions and may be sensitive to Gleason grade.

CLINICAL RELEVANCE/APPLICATION

New features extracted from multi-echo TSE images are more sensitive to prostate cancer and Gleason score than T2 values alone which may improve prostate cancer diagnosis.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Aytekin Oto, MD - 2013 Honored EducatorAytekin Oto, MD - 2017 Honored Educator

SSK17-04 Comparison between Readout Segmented Diffusion Weighted Imaging and Single Shot Echo Planar Imaging in Image Quality

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S404AB

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PURPOSE

To compare difference of readout segmented diffusion weighted imaging (RS-EPI) and single shot echo planar imaging (SS-EPI) on image quality with ultra-high b value for prostate cancer detection.

METHOD AND MATERIALS

37 patients with prostate disease who underwent both RS-EPI and SS-EPI were enrolled in this study. All data were collected on a MAGNETOM Skyra 3T MR scanner (Siemens AG, Erlangen, Germany) with the b value of 0,1000,2000,3000s/mm2. The image quality including lesions clarity, anatomical distortion, image sharpness, detail display based on diffusion weighted imaging (DWI) were classified according to Likert score into 1 to 5 grade.(Grade 1 : cannot be used for diagnosis; Grade 2: poor; Grade 3: acceptable; Grade 4: good; Grade 5: very good.) All the images were analyzed by two experienced radiologists blinded to any clinical information as well as MR sequence information. The classification was provided from two radiologists separately. The signal-to-noise ratio (SNR), and contrast ratio, and contrast to noise ratio (CNR) were also measured on workstations by the radiologist.

RESULTS

The scores concluded by the two radiologists have good consistency, Kappa value>0.80. The image quality including lesions clarity, anatomical distortion, image sharpness, detail display obtained from RS-EPI sequences were higher than those obtained from SS-EPI regardless of 1000,2000,3000s/mm2 (P<0.001). The signal-to-noise ratio (SNR), and contrast ratio, and contrast to noise ratio (CNR) measured on RS-EPI sequences were also higher than those measured on SS-EPI (P<0.001) (table1).

CONCLUSION

Compared with the SS-EPI sequence, ultra high b value RS-EPI sequence significantly improves the image quality, which is more conducive to the detection of prostate lesions.

CLINICAL RELEVANCE/APPLICATION

Compared with the SS-EPI sequence, ultra high b value RS-EPI sequence significantly improves the image quality, which is more conducive to the detection of prostate lesions.

SSK17-05 Magnetic Resonance Water-Fat Separation using Deep Machine Learning

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S404AB

Participants
James W. Goldfarb, PhD, Roslyn, NY (*Presenter*) Nothing to Disclose

PURPOSE

The goal of this study was to develop, train and evaluate a convolutional neural network for decomposition of cardiovascular MR images into separate water and fat images with additional calculation of R2* and off-resonance.

METHOD AND MATERIALS

1204 cardiac images in multiple anatomical orientations from 90 imaging sessions acquired at 1.5T using a dark blood double inversion recovery multiple spoiled gradient-echo sequence (TR=20ms; 12 TEs=2.4-15.5ms (1.2ms spacing), bipolar gradient acquisition) were included in this study. This included 15 acute myocardial infarction (MI), 24 sub-acute MI, 34 chronic MI subjects and 17 normal subjects. Water-fat separation was initially performed with a conventional model based technique providing water, fat, R2* and off-resonance images for deep learning training. A U-Net convolutional neural network (CNN) was used for deep learning. The input to the CNN was 24 real and imaginary images from 12 TEs. The output of the CNN was four images (water, fat, R2* and off-resonance). The implementation was done using open source software written in Python v2.7 with the TensorFlow v1.1 and Keras v2.0 machine learning libraries. Training on 900 (x12 echo-times) complex images with 50 epochs was performed using the Adam optimizer with Nestrov momentum. Water and fat images from the data not used for training (n=304) were predicted using the trained CNN. Water-fat fraction images were constructed for both the conventional and deep learning approaches.

RESULTS

Water-fat separation performed well across all image slice orientations. Signal-to-noise was better in the deep learning images when compared to conventional images, $p<0.001$. Fine details were preserved in the deep learning images when compared to conventional images. There was an excellent correlation ($R2=0.97$, $p<0.001$) between the conventional and deep learning fat fraction measurements. Multiple pathologies were visualized with deep learning, including fatty metaplasia (Fig 1a) and intramyocardial hemorrhage (IMH) Fig 1b.

CONCLUSION

Deep learning is a robust, efficient, feasible method for water-fat separation. After the learning phase, utilization is computationally efficient and can make use of echoes with bipolar gradients.

CLINICAL RELEVANCE/APPLICATION

Deep machine learning can provide fat suppressed images and quantitative fat fraction maps with R2* and off-resonance corrections in challenging situations such as cardiovascular imaging.

SSK17-06 Analysis of Different Image Registration Algorithms for Fourier Decomposition MRI in Functional Lung Imaging

Wednesday, Nov. 29 11:20AM - 11:30AM Room: S404AB

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PURPOSE

To evaluate different image registration algorithms for Fourier decomposition MRI (FD-MRI) in functional lung imaging in healthy subjects.

METHOD AND MATERIALS

Fifteen healthy volunteers (mean age 33.0±10.1 years) were examined on a 1.5 T whole-body MR-scanner (Magnetom Avanto, Siemens AG) with a non-contrast enhanced 2D-TrueFISP pulse sequence in coronal view (TR/TE 2.06/0.89 ms, acquisition time 180 ms/image, 250 images). No ECG or respiratory triggering was used. Three different image registration algorithms (fMRLung 3.0, Siemens Corporate Research; diffeomorphism based ANTs by Avants et al. NeuroImage 2011; Elastix by Staring et al. Medical Physics 2007) were used to compensate the spatial variation of the lung structure. Quality control for the image registration was performed by quotient images (ΔQ) and dice similarity coefficient (ΔD). The impact of the used registration algorithms on the calculated perfusion and ventilation values by Fourier decomposition method was evaluated.

RESULTS

The average time for motion correction by the different image registration algorithms were for fMRILung 1.0±1.6 min, ANTs 38±13.5 min and Elastix 5.9±1.3 h, respectively. No significant ($p>0.05$) difference in the quality of the motion correction provided by different image registration algorithms (ΔQ fMRILung 0.12, ANTs 0.11, Elastix 0.11; ΔD fMRILung 0.06, ANTs 0.07, Elastix 0.06) occurred. Further no significant difference of the calculated ventilation and perfusion values between the different registration algorithms ($p>0.05$) were determined. The calculated ventilation values were 119±12 for fMRILung, 110±14 for ANTs and 118±12 ml/min/100 ml for Elastix, respectively. The perfusion values for fMRILung, ANTs and Elastix were 156±41, 166±46 and 185±66 ml/min/100 ml, respectively.

CONCLUSION

The mandatory motion correction for the calculation of perfusion and ventilation images by FD-MRI is possible with different image registration algorithms without significant influence on the quality of the motion correction or changes of the calculated functional lung values. fMRILung 3.0 (Siemens Corporate Research) provides the fastest way of motion correction.

CLINICAL RELEVANCE/APPLICATION

Motion correction for FD-MRI is possible with different image registration algorithms without loss of accuracy of perfusion and ventilation results.

SSK17-07 MRI Quantitative Quality Control and Calibrated Measurement with DTI and Reference Fluid Phantom Novel Phantom for Quantitate Assessment of DTI Inters Canner Variability

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S404AB

Participants
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CONCLUSION

Current DTI scanning has substantial systematic error, distorting measurement and impairing clinical diagnostic stability. Phantom calibration can quantify such errors and may provide a means for a correction factor to reduce variability across scanners.

Background

We used a novel DTI and isotropic fluid phantom funded by the Chronic Effects of Neurotrauma Consortium, VA, DoD & NIH QIBA programs to provide "ground truth" reference measurement and quality assurance metrics.

Evaluation

The phantom contains anisotropic diffusion components of hollow textiles termed Taxons (axon-shaped tubes, 12-µm inner diameter diffusion chambers) arranged in water-filled bundles of > 100,000. To quantify loss of tract integrity and size, we created tracts with densities of 12.5%- 100% and tract cross-sections of 4-100 mm2. The phantom includes 32 NIST reference fluids (T1, T2, PD, ADC) for isotropic reference metric correction. We imaged on 11 scanners (1.5T and 3T, Siemens, GE & Phillips) with head coils 12-64 channels. Scans detected tracts with high spatial detail at all sizes (average correlation of FA to tract density r=0.992). We found tight repeat measurements, with small changes between scans on the same magnet within a few weeks. However, substantial (35%) inter-scanner systematic error/biases in measurements of FA were seen, greatly exceeding presumed effect size of TBI-induced FA change and 2.85 times the variance within scanner. We applied a reference measurement correction by estimating scanner-specific systematic error on one scan and applying that correction to a second scan weeks later to calculate calibrated FA relative to the mean cross-scanner FA to reference density metrics. The correction reduced the across-scanner spread error by 94%.

Discussion

The phantom provides a reliable and reproducible method to determine degree to which DTI scans on a MR scanner differ from a reference standard that simulates the microstructure of brain white matter. The phantom also allows a means to determine the degree to which DTI scans from multiple scanners differ from one another and, potentially, a method to correct for inter-scanner differences.

SSK17-08 A Quality Improvement (QI) Initiative to Evaluate MR QA Training Strategies for MR Technologists to Enable Them to Undertake Quality Assurance (QA) Testing in MRI

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S404AB

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PURPOSE

The American College of Radiology (ACR) standard recommends that quality assurance (QA) testing of MR systems is the responsibility of both technologists and medical physicists to ensure efficient scanner performance. However, in the Kingdom of Saudi Arabia (KSA), meeting this standard is challenging due to a shortage of medical physicists, variable MR-specific education amongst technologists, and difficulties in achieving standardisation across centres providing MR imaging services. These factors have contributed to low compliance with recommendations for the performance of MR QA tests. This study explored the development of an education-based Quality Improvement (QI) initiative to enable MR technologists across multiple clinical sites to consistently perform MR system QA testing. The authors aimed to develop an educational tool to provide MR QA training to technologists enabling them to undertake this activity in their departments.

RESULTS

There was 95% agreement between the expert-determined and technologist-determined MR QA test results. Interview findings revealed that all technologists reported that the test methods presented in the training video were clear and logical, and enabled them to perform practical QA testing of their scanner. 12% of technologist participants (n=1) acknowledged some difficulty positioning the QA phantom, and 50% (n=4) indicated challenges interpreting the test pattern appearances due to the inherent subjectivity of the low contrast detectability QA test. All participants indicated that their experience of MR QA training was positive, using expressions such as "I enjoyed it", "It was a positive experience", and "very good experience", "It showed me what I can do with the right training". Technologists indicated they had learned a new skill to help them improve the quality of the MR imaging service they provide, and were willing to continue undertaking QA testing, seeing this as one way to expand their professional role.

CONCLUSION

With the ongoing shortage of medical physicists in KSA and other countries, the training video introduced as a QI initiative

With the ongoing shortage of medical physicists in KSA and other countries, the training video introduced as a QI initiative demonstrated the effectiveness of an appropriately designed educational resource combining both technical information and practical skills demonstration. The ease of access and display means that this educational tool can readily be made available to MR technologists across multiple centres in KSA, as a strategy to prevent a shortage in expert personnel limiting the implementation of practices to optimise MR service quality. The broader application of the methods applied during this education-based QI is apparent.

METHODS

Educational Tool Design: A training video was designed to demonstrate MR QA test methods and provide background explanatory information. sing a focus group discussion framework, the research team, comprising two medical physicists and four MR technologists, reached consensus regarding the essential content and presentation format, drawing on ACR MR QA guidelines and the expertise of group members. Based on ACR recommendations, the method for the following QA tests was planned: central frequency, geometric accuracy, high-contrast spatial resolution, low-contrast detectability, image intensity uniformity and signal-to-noise ratio (SNR). Each test was broken down into logical steps which included: MR QA phantom design features, set-up and positioning, pulse sequence and parameters and use of MR images to provide numerical indicators of MR system performance. The performance of these steps by the research team members for each QA test was videoed in sequential order to make it easy for the MR technologists to follow the test method. Editing of the video footage and overlay of audio content was performed by a videographer in consultation with the research team. Educational Tool Evaluation: MR technologists (n=8) in one public (n=4) and one semi-public (n=4) hospital in KSA evaluated the QA training video. Technologists were given supervised access to this resource for two 30-minute sessions per day over one week. A supporting booklet outlining the test methods was also provided. On completion of the educational intervention, each technologist was asked to implement the QA test process in their MRI department for a three-month period by individually conducting weekly QA testing on the MR scanner and documenting the images and numerical results for each test. These findings were compared to images and values independently determined for the same QA tests on each MR scanner as performed by an expert in MR QA following the methodology outlined in the training video. Face-to-face semi-structured interviews were conducted with each technologist to ascertain their opinion regarding the effectiveness of the QA training video and their experiences undertaking the QA tests.

PDF UPLOAD

https://abstract.rsna.org/uploads/2017/17016601/17016601_ox5k.pdf

SSK17-09 A Microwave Imaging System and Real-Time Image Reconstruction Algorithm for Intraoperative 3D Monitoring of Thermal Ablation Therapies

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S404AB

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CONCLUSION

We proposed a 3D real-time microwave monitoring method and synthetically validated it for interstitial thermal therapy monitoring. We will further validate on animal models before moving to clinical trials. With this intraoperative temperature monitoring, radiologists will be able to more selectively target tumors, extend the application of thermal ablation to new therapeutic areas, and reduce surgery time.

Background

Thermal ablation is a minimally invasive surgery that is gaining increasing popularity as first-line therapy for soft-tissue tumors. However, its application has been limited by inadequate thermal image guidance. Fiber optic sensors measure temperature only at their tips. B-mode ultrasound is limited to 2D. MRI is not available within the operating room and adds 30-40 minutes to surgery time. To address these challenges, we have developed a microwave monitoring system that can intraoperatively provide a 3D real-time temperature map. The system consists of a multi-antenna imaging cavity, where microwave measurements are collected with a network-analyzer-based measurement system. The data is processed with a differential inverse scattering algorithm, which generates real-time 3D temperature images through a mapping between tissue dielectric change and temperature. In our prior work, the system has been experimentally validated using laboratory phantoms heated with an ablation probe.

Evaluation

To synthetically test the monitoring of the ablation process in the case of brain tumor treated with thermal therapy, we derived a 3D dielectric brain phantom from MRI and simulated the heating of the target region with a multi-physics model of an interstitial ablation probe. In the test, the target region is heated from 37 °C to 70 °C, and 3D temperature maps are generated throughout the procedure.

Discussion

Sample validation results are shown in the figure attached. The 3D temperature maps can be generated as fast as 1 frame/second, provide a resolution of 1 cm, and can track temperature change as small as 1 °C. To further improve temperature accuracy, the mapping model between dielectric and temperature change is currently being refined with empirical studies using *in vitro* tissue samples.

SSK18

Physics (CT: Radiation Dose II)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S503AB

CT PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSK18-01 Experience with Different Automatic Tube Voltage Selection Software (kV Assist and Care kV) on Four CT Platforms

Participants
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PURPOSE

To assess the effect of ATVS on the applied tube voltage, tube current, image quality and radiation exposure across four scanners from two vendors.

METHOD AND MATERIALS

In this IRB approved study, 341 subjects (age: 58 ± 17 years) underwent abdominopelvic CT exams with ATVS technique set at a reference value of 120kVp on four recently introduced CT platforms. kV assist: Revolution CT, GEHC (Group A, n=90); CarekV: Somatom Definition Flash, Siemens (group B, n=16), Somatom Definition Force, Siemens (group C n=82) and Somatom Definition Edge, Siemens (group D n=153). Subjects were categorized based on body weight (<150lb, 151-200lb, >201lb). Images were reconstructed using ASIR-V 40% for group A, SAFIRE 3 for groups B and D, and ADMIRE A3 for group C. In 86 additional subjects, 100 kVp was selected as reference for ATVS (Group E; Revolution CT). Applied scan parameters (tube voltage and mean tube current) and radiation dose (SSDE) were compared for all body weight categories among the groups; ANOVA was performed.

RESULTS

There was no significant difference in body weight among subjects in groups A-E within each category ($p>0.05$). Across all groups and weight categories, low tube voltage (<120 kVp) was selected in 48% of exams (165/341). 5% of exams (19/341) were scanned using 90kVp (<200lb). Majority of low kVp scans were performed in subjects <200lb (147/165). Low kVp was selected in 21.6% of subjects (18/83) >201lb. Highest number of low kVp acquisitions were found in Group D (70%) followed by group C (61%) and Group B (31%). Only 3.3% of exams (3/90) in group A (all <200lb) were performed using 100kVp. However, 86% of exams (74/86) were acquired at 100 kVp in group E. SSDE (mGy) was 12.9 ± 3.3 in group A, 10.9 ± 2.4 in group B, 11.5 ± 3 in group C, 11.2 ± 3.2 in group D, and 7.7 ± 2.2 in group E ($p<0.01$).

CONCLUSION

The kVp selection with ATVS not only depends on body composition but on the reference kVp setting and tube current capacity. Using reference of 120kVp, careKV (Siemens) selected low kVp in 31-70% of exams. Using a reference of 100kVp on kV assist (GE), low kVp selection increased to 86% of exams independently of the body weight.

CLINICAL RELEVANCE/APPLICATION

Due to higher image contrast and lower radiation dose, clinical practice is drifting towards low kVp CT acquisitions. Knowledge of ATVS software selection of kV options can facilitate implementation in clinical practice without degrading image quality or CT workflow.

SSK18-02 Automatic Mapping of CT scan Locations on Computational Human Phantoms for Accurate Organ Dose Estimations for a Large Number of Patients

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S503AB

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PURPOSE

Using Monte Carlo simulations of CT scanners and computational human phantoms, there are several computational solutions available for organ dose estimation from CT. Although most scan parameters can be extracted from DICOM, it is still necessary to manually map the scan locations of patients on phantoms which may cause significant dose difference for organs near the scan boundaries. We developed a method to automate the mapping process and applied it to organ dose estimation for 60 chest CT patients.

METHOD AND MATERIALS

We generated a two-dimensional antero-posterior projection image of the skeleton from given patient CT images. We compared the patient skeleton image with a pre-generated skeleton image from a reference whole body phantom from the top of the head to the bottom of the feet with 1 cm increment to find the best Dice matching score. The mapping algorithm was tested for five partial torso CT sets (22 image sets from the top clavicle with 20 cm scan length with 2 cm increment for each patient) simulated using five full torso CT sets. Illustrative organ doses were calculated for 60 chest CT patients using the algorithm combined with an in-house CT dose calculator. Automatic mapping algorithm-based organ doses were compared with the data based on the scan location manually mapped by experienced medical physicists.

RESULTS

Comparison of the scan location of simulated partial torso CT with the values of automatically-mapped location in phantoms showed very good agreement (less than 10%) with the Dice score of 57% on average. The automatic detection of the scan location took about a minute per CT. The illustrative organ dose for 60 chest CT patients showed significant difference up to 5-fold for some organs located atnthe scan boundaries across the 60 patients. The organ doses from the automati. Mapping algorithm agreed within 5% with the values calculated from manual mapping of scan locations.

CONCLUSION

Our method will provide faster and more accurate organ dose estimation compared to existing approaches in cases requiring organ dose for a large number of patients such as patient dose monitoring, clinical trials, and epidemiological studies.

CLINICAL RELEVANCE/APPLICATION

The new methods we developed in this study will provide with more accurate patient-specific organ doses, which will help radiologists and patients to better understand the health impact of CT scans.

SSK18-03 A Personal Organ Dose Archive System for Patient Safety in Radiotherapy

Wednesday, Nov. 29 10:50AM - 11:00AM Room: S503AB

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PURPOSE

Although state-of-the-art radiotherapy techniques have improved local tumor control over the years, normal tissue complication is still of concern in the clinic. Estimation of normal tissue doses depend primarily on treatment planning system (TPS). However, leakage and scatter doses, imaging doses and doses to non-contoured organs are not well considered by modern TPS. In this work, we aim to develop a personal organ dose archive (PODA) system for individual patients undergoing radiotherapy to track doses of all relevant organs from all radiation events.

METHOD AND MATERIALS

CT images, contours and treatment parameters are exported and extracted from TPS via DICOM format. Deformable image registration and dose mapping are performed with MIM with 3D volumetric imaging. GPU-based Monte Carlo dose engine is used for super-fast 3D dose calculation in patient anatomy. A SQLite database is deployed to manage the data registration and inquiry.

RESULTS

Our PODA system includes four parts: (1) DICOM library; (2) PODA database; (3) GPU-based Monte Carlo dose engine; (4) functional modules. DICOM library hierarchically stores all the raw data for each individual patient. PODA database organizes and manages the general information of all patients. GPU-base dose engine computes organ doses and outputs to PODA database for each event involving ionizing radiation. Major functional modules include Update Organ Dose, Report & Alert and Database Backup & Recovery. The four components work together to track patient organ doses on a daily basis. A proactive early warning is issued if organ dose will exceed pre-set dose criteria by prediction.

CONCLUSION

We have developed a PODA system that can be used to track and accumulate each patient's organ doses associated with the use of sophisticated treatment technologies and image-guidance procedures in modern radiotherapy.

CLINICAL RELEVANCE/APPLICATION

With PODA we can provide an important safety mechanism to help prevent irreversible radiation damage to normal tissues and provide a comprehensive organ dose database to help clinicians make informed decisions for individual patients including pre and

post care management.

SSK18-04 Comparison of Image Quality and Radiation Dose of Female Chest CT Using Organ Dose Modulation with Different Detector Coverage on 16cm Wide-detector CT

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S503AB

Participants
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PURPOSE

To evaluate the impact of two different detector coverages (80mm and 40mm) on image quality and radiation dose of the female chest CT using organ dose modulation (ODM).

METHOD AND MATERIALS

Forty female patients undergoing chest CT with clinical justifications were prospectively and randomly assigned to two groups: Group A (n=20) with 80mm detector coverage and pitch 0.992:1; Group B (n=20) with40mm detector coverage and pitch 0.984:1. Both groups used the 0.5s rotation speed and the SmartmA and ODM technique for the breasts. The standard deviation (SD) in the aortic arch, carina, and inferior pulmonary vein in both the anterior and posterior lungs were measured. Image quality was evaluated by two experienced radiologists using a 5-point scoring system. The tube current in different directions (A/L/P/R) were recorded from mA Table. The CTDIvol and DLP values were recorded from dose report and effective dose calculated. The above parameters for the two groups were analyzed using SPSS 20.0.

RESULTS

There was no difference in the anatomic coverage between the two groups (258.75 ±27.85mm vs. 253.00 ±24.51mm). However, Group B with 4mm collimation had lower tube current in all four directions and reduced over-scan range than Group A (29.50±0.60mm vs. 59.40±7.47mm, P<0.05), resulting in 25% lower radiation dose in Group B compared with Group A (0.74±0.13mSv vs. 0.99±0.33mSv). . The ODM feature worked in both groups, and the tube current in the anterior was lower than that in the posterior in both groups (P<0.05), and produced about 30% radiation reduction for the breasts in both groups. There was no significant difference in SD for the aortic arch, carina, and inferior pulmonary vein level between the two groups. The image quality of two group were judged to be clinically acceptable. There was no significant difference in subjective image quality grading (p>0.05) with excellent agreement between the two radiologists (Kappa=0.77, P<0.001).

CONCLUSION

The use of helical scan with 40mm collimation and ODM chest CT ensures good image quality with 25% reduced radiation dose, compared with chest CT that uses helical scan with 80mm collimation and ODM.

CLINICAL RELEVANCE/APPLICATION

The use of helical scan with 40mm collimation and ODM chest CT can dramatically reduce radiation dose while maintaining image quality compared with helical scan with 80mm collimation and ODM.

SSK18-05 Efficacy of Organ Dose Modulation and Metal Artifact Reduction Techniques on Reducing Exposed Radiation Dose on Abdominopelvic Computed Tomography Scans With Metal Hip Prosthesis

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S503AB

Participants
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PURPOSE

To evaluate the effect of metal hip prosthesis on exposed radiation dose and assess the efficacy of organ dose modulatation (ODM) and metal artifact reduction (MAR) protocols on dose reduction.

METHOD AND MATERIALS

Six patients with history of total hip arthroplasty who had both preoperative and postoperative abdominopelvic CT scans using an identical protocol were selected and their preoperative and postoperative CT dose index (CTDI, mGy) were compared. An anthropomorphic phantom was scanned with and without bilateral metal prostheses and exposed surface and deep doses (mGy) at pelvic and extrapelvic cavities were measured using nanoDot dosimetry system. Finally, exposed radiation doses using reference scans, ODM, and two MAR protocols (GSI32 and GSI3; CTDI equivalent to reference scan without and with metal prosthesis respectively) in pelvic and extrapelvic cavities were compared.

RESULTS

Among six patients, the mean CTDI (mGy) increased by 18.1% after metal hip prosthesis implantation (p=0.028, Preoperative CTDI: 8.64±2.47, Postoperative CTDI 10.20±3.51). On phantom experiment, adding unilateral or bilateral metal prosthesis in pelvis increased CTDI (mGy) by 14.4% and 30.5% respectively. The tube currents were also increased in pelvic cavity but the metal hip

prosthesis had no effect on the tube currents of extrapelvic area. The utilization of MAR and ODM protocols decreased both the surface and the deep organ doses in pelvis. GSI32 showed the most significant dose reduction in the deep pelvic cavity followed by GSI3 and ODM. However, MAR (GSI32, GSI3) protocols increased radiation doses in extrapelvic cavity compared to the reference scan. ODM showed significant reduction of both the surface and deep organ doses in the extrapelvic cavity.

CONCLUSION

Metal hip prosthesis implantation increased exposed radiation doses in abdominopelvic CT scans. MAR protocol can be utilized to reduce the exposed radiation doses in pelvic cavity while improving image quality. When MAR protocol is not applicable, ODM is an alternative protocol that can be utilized to reduce exposed radiation doses of both pelvic and extrapelvic cavities.

CLINICAL RELEVANCE/APPLICATION

Metal artifact reduction and organ dose modulation techniques reduce radiation doses in patients with metal prosthesis implantation.

SSK18-06 Impact of Adjusting the Pulmonary-Embolism CT-protocol on Female Fertility Preservation by Reducing the Radiation Exposure of the Ovaries

Wednesday, Nov. 29 11:20AM - 11:30AM Room: S503AB

Participants
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PURPOSE

To assess in female patients undergoing a clinical pulmonary-embolism CT-protocol the relative and absolute reduction of the radiation exposure on the gonads by using a modified protocol that imposes a caudal imaging limit of the costodiaphragmatic recesses, in lieu of the common imaging window which also captures the supraadrenal glands. Cumulative exposure to radiation remains a concern due to the rising maternal age at primigravida, and the often unavailable exposure during emergencies such as suspected pulmonary embolisms.

METHOD AND MATERIALS

Thirty non-pregnant female patients with suspected pulmonary embolism underwent a contrast enhanced CT of the chest on a 3rd generation dual source CT (SOMATOM Force, Siemens Healthcare) in single-energy mode with automatic tube voltage selection and tube current modulation. Organ dose of the ovaries was automatically calculated using a commercial dose tracking software (Radimetrics, Bayer Schering). Full assessability of the thoracic cavity was assured with the modified imaging window, although incidental findings of e.g. suprarenal growths were precluded.

RESULTS

Median age of the patients analyzed in the retrospective study was 35 years [17 - 42]. The median equivalent dose of the gonads was 0.031 [0.009 - 0.190] mSv for the adapted (shrunk imaging window) and for the non-adapted protocol (typical size imaging window) 0.060 [0.013 - 0.266] mSv. The reduction in radiation dose was statistically significant ($p<0.0001$). The mean absolute difference in the ovarial radiation dose amounted to 0.041 ± 0.031 mSv, corresponding to a relative reduction in gonadic exposure of 43.8%.

CONCLUSION

For female patients prior to menopause in general, and their subgroup with a history of suspected pulmonary embolisms and thus repeated thoracic CT imaging specifically, an adaption of the CT protocol as outlined conveys a significant cumulative reduction of the radiation exposure on the ovaries.

CLINICAL RELEVANCE/APPLICATION

Shortening the scan range of pulmonary CTA positively affects the ovarian radiation exposure, important in pre-menopausal women undergoing repetitive scans.

SSK18-07 CT-Guided Periradicular Infiltration Therapy: How IR and Protocol Modifications Contribute to Achieving Ultra-Low-Dose

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S503AB

Participants
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PURPOSE

To evaluate robustness and safety of ultra-low-dose protocols for CT-guided periradicular infiltration of the cervical and lumbosacral spine on a CT scanner with iterative reconstruction software.

METHOD AND MATERIALS

This retrospective study included a total of 366 patients who underwent periradicular infiltration therapy of the cervical (n=191) and lumbar (n=175) spine. Respective study group (90 each cervical and lumbosacral) was treated on a new CT scanner with a new intervention protocol using an iterative reconstruction algorithm. Spot scanning was implemented for planning purposes and a basic low setup of 80 kV (cervical) or 100 kV (lumbosacral) and 5 mAs was established during intermittent fluoroscopy. The comparison group comprised 101 (cervical) and 85 (lumbosacral) prior interventions on a scanner without iterative reconstruction software. Dose-length product, number of acquisitions, pain reduction on a numeric analogue scale and protocol changes to achieve a safe intervention were recorded.

RESULTS

Median DLP for the whole intervention was 24.3 mGy*cm in the cervical and 49.3 mGy*cm in the lumbosacral comparison group towards 1.8 mGy*cm in the cervical and 3.2 in the lumbosacral study group. Pain reduction was median -2 in all the cervical and lumbosacral study and comparison group. Raise of the tube current-time product by 5 mAs was needed in 5 patients of the cervical and 3 patients in the lumbosacral study group.

CONCLUSION

Implementation of a new ultra-low-dose intervention protocol resulted in a reduction of dose by 92.6% (cervical) and 64.0% (lumbosacral) without limitation of safety and pain relief.

CLINICAL RELEVANCE/APPLICATION

Dose reduction in CT imaging is of relevant interest from patients and physicians perspective. Changes of the scanner parameters and implementation of IR can significantly reduce overall dose also of interventional procedures. This dose reduction does not impact the procedure itself nor the outcome as seen in periradicular infiltration.

SSK18-08 Prospective Evaluation of Ultra-Low Dose Enhanced Abdominal Computed Tomography (MDCT) Using 100 kV with Tin Filter as Spectral Shaping: Effect on Radiation Dose Reduction and Image Quality with a Third-Generation Dual-Source CT System

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S503AB

Participants
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PURPOSE

The purpose of this prospective study was to investigate the radiation dose exposure and image quality of enhanced abdominopelvic single-energy MDCT using a tin filter at 100Kv tube voltage in comparison to the standard enhanced acquisition.

METHOD AND MATERIALS

110 medium size oncologic patients (BMI:25±3.2kg/m2) over 60 years old (mean age:73.2±10.2 years) referred for an enhanced abdominopelvic MDCT examination underwent in addition to our conventional protocol an ultralow dose acquisition with tin filter (TF) in portal venous phase. Our institutional ethical committee reviewed and approved our investigation. The examinations were performed in single energy helical mode with a third-generation dual-source CT (Somatom Force). Both standard acquisition (SP) with an automatic individually-adapted kV (90-110) and tin filter (TP) (100 Sn kV/300mAs) were acquired with automatic milliamperage modulation and identical length of coverage, pitch, reconstructed slice thickness of 2mm, acquisition time and ADMIRE strength : 4. Radiation dose was recorded as dose-length product (DLP), volume CT index (CTDIvol). Effective dose (ED) was calculated. Subjective image quality was evaluated on a 5-grade scale by two blinded independent radiologists and interobserver agreement was calculated. Objective image quality was calculated by signal-to-noise ratio (SNR). The attenuation with standard deviation in liver and psoas muscle were assessed.

RESULTS

Radiation dose was reduced by 82-84% withTF compared to SP (DLP : 290±12.0 vs 49.6± 3.2 mGy.cm; p<0.0006, CTDIvol:1.32±0.36 vs 7.25±1.64 mGy; p<0.0001, ED : 4.93±0.2 vs 0.84±0.1 mSv ; p<0.0005). The image quality was rated as excellent for both (4.5 for TF, 5 for SP) with an excellent interobserver agreement (Kappa =0.87). All abnormalities discovered on SP were identified on TF. SNR was not significantly different with TF in liver (9.53±0.9 vs 8.10±1.1; p : 0.08) or psoas (6.03±1.5 vs 5.46±0.2 ; p : 0.06), respectively. Attenuation values were slightly lower with TF (91±14HU vs 102±12HU, 52±16HU vs 65±10HU; p= 0.06) for liver and psoas muscle, respectively

CONCLUSION

An ultralow radiation dose (ED<1mSv) for abdominopelvic CT is achieved using a tin filtration as spectral shaping at 100 kV without

degradation of image quality and diagnosis confidence in medium size patients.

CLINICAL RELEVANCE/APPLICATION

The TF acquisition should be proposed for enhanced abdominal CT follow up examinations in oncologic patients.

SSK18-09 Reducing Variability of Radiation Doses in CT

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S503AB

Participants
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CONCLUSION

Significant decrease of variance in head, chest, and abd/pelvis CT was achieved using a combination of standardizing protocols across the network and implementing advanced software that effectively managed radiation dose.

Background

While reducing radiation is an important goal, also important in the management of radiation dose is ensuring consistency in the amount of radiation administered for each type of study. Being able to consistently administer the same dose everytime a study is performed is the hallmark of high quality in radiation management. We implemented an approach to reducing variance in CT dose by standardizing protocols and employing software at the scanner to provide consistency across the network.

Evaluation

We measured variance of dose administered to head, chest, and abd/pelvis CT in two periods. The first period is pre-intervention: 1/1/13-7/31/14. We then measured the period after intervention: 1/1/16-12/31/16. Statistical analysis for differences in variability of radiation dose pre- and post-intervention used Bartlett's test. Pre-intervention dose and SD: head CT (n= 12,002): 26.4 CTDI with SD of 4.3; chest CT (n=3,149): 8.6 CTDI with SD of 5.2; abd/pelvic CT (n=9833) :12.5 CTDI with SD of 5.2. Post-intervention dose and SD: head CT (n=13,274): 20.1 CTDIvol with SD of 3.4; chest CT (n=3,746): 5.4 CTDI with SD of 2.7; abd/pelvis Ts (n=12,121): 7.7 CTDI with SD 3.3. Post intervention SD was significantly decreased for all studies ($p<0.001$).

Discussion

Our approach to reducing variability in radiation CT was a multifaceted approach: 1. Establishing the Radiation Dose Optimization Committee, 2. Standardizing Protocols, and 3. Implementing scanner software which reduces variance of dose. We implemented software in scanners that increases tube current to a lesser degree than would be obtained by hold noise constant. The software increases tube current for increasing diameter size at a rate less than would be needed to hold noise constant. Thus for larger patients,allowing for controlled increase in dose to improve signal to noise yet also accepting more noise allowed for better dose management avoiding exponential increase in radiation that occurs with conventional dose modulation.

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SSK19

Radiation Oncology (Outcomes and Quality of Life)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: S104A

RO OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Kathleen Horst, MD, Stanford, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSK19-02 Prospective Investigation of the Association of Pre-Treatment Depression with Quality of Life during Radiotherapy for Prostate Cancer

Wednesday, Nov. 29 10:40AM - 10:50AM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): Cancer survivors often experience psychological stress, with impact on quality of life (QOL) and mortality. Better understanding the heterogeneity in individuals' psychological adjustment to cancer diagnosis and treatment may help identify valid screening practices for those most in need of psychosocial support. The specific aim of the current study investigates the role of psychological state prior to treatment on the course of QOL during radiotherapy for localized non-metastatic prostate cancer. We hypothesized inverse correlations between depression and QOL. We also categorized participants in three groups based on depressive symptoms (i.e., minimal, mild, moderate+) and hypothesized a significant between group difference in QOL as measured pre-, mid-, and post-treatment.Materials/Methods: The PHQ-9 assessed depression. We grouped participants into Minimal (n=22), Mild (n=8), and Moderate or higher (n=6) depression groups based on PHQ-9 score. The FACT-P assessed QOL, including physical, social, emotional, and functional well-being. Our total sample (N=41) had mean age of 68 (range 54-81) and education of 15.5 years (range 10-20). Most participants (33; 80%) identified as European-American. There were no between-group differences in age, education, or ethnic identity. Repeated measures ANOVA assessed effects of group and time. Associations of variables of interest were also assessed by Pearson's correlation coefficients.Results: Significant inverse correlations were observed between depression and QOL pre-treatment (p p p F (1,33)=16.49, ppConclusion: These analyses reflect strong inverse correlations between degree of depressive symptoms and QOL pre-, mid-, and post-treatment. Investigating subgroups based on extent of depressive symptoms was also illuminating in that QOL characteristics of the "moderate or higher" group were distinct from the other two groups, which did not significantly differ from one another. Indeed, a "mild" degree of depression may not be unexpected in inherently distressing circumstances. These findings support the conclusion that there may be a useful clinical cutoff on the PHQ-9 (e.g., mild vs. moderate) for triggering psychosocial support or other intervention. We are of course limited by small samples in our subgroups and these findings can therefore be considered preliminary. Future directions include investigation into other potential contributors to QOL changes, as well as investigation of these factors in other disease or treatment groups.

SSK19-04 Stereotactic Body Radiation Therapy (SBRT): A Strategy to Reduce Disparities in African American Men with Localized Prostate Cancer?

Wednesday, Nov. 29 11:00AM - 11:10AM Room: S104A

Participants
Robert Dess, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Prostate cancer (PCa) is the most common cancer in men, and African-Americans (AA) consistently have inferior outcomes compared to Caucasians (C). Technological advances that improve access to care may be one strategy to address this disparity. Stereotactic Body Radiation Therapy (SBRT) is a convenient, non-invasive course, typically involving 5 treatments over a few weeks. In a large cohort with prospectively collected health-related quality of life (HRQOL) data, we sought to explore early efficacy and HRQOL differences between men who self-report as AA compared to C race.Materials/Methods: Between 2008 and 2014, 752 consecutive men were treated with localized, node negative prostate cancer per an institutional protocol. Inclusion criteria for the present study included men with low and intermediate risk PCa treated with SBRT with or without androgen deprivation therapy (ADT). Prospective HRQOL data in the urinary, bowel, sexual and vitality domains were collected via the Expanded Prostate Cancer Index Composite (EPIC)-26 form along with other baseline demographics (Charlson comorbidity,

Anticoagulation use, Partner status, Diabetes (DM), Hypertension, Dyslipidemia, and Coronary artery disease). Cox multivariable analyses (MVA) were utilized to compare 5-year biochemical progression-free survival (bPFS) and 2 year HRQOL between AAs and Cs. Results: The median follow-up was 4.1 years. Of the 510 men who met eligibility criteria, 53% (n=270) were C, 40% (n=202) AA, and 7% (n=38) other. The cohort included 33% low, 38% favorable intermediate (Fav-Int), and 29% unfavorable intermediate (Unfav-Int) risk men, and rates were similar between AAs and Cs (p=0.44). AAs were younger at diagnosis (67 vs 70, p0.05). AA were less likely to report partners (70% vs 82%, p=0.04) or depression (0% vs 10%, pConclusion: In a prospectively followed cohort, tumor control and HRQOL were similar across low and intermediate risk men treated with prostate SBRT, even when adjusting for baseline differences. Long term follow-up is needed to confirm these promising results.

SSK19-05 Patient Safety in Radiation Oncology Departments in Spain: Preliminary Results of the First National Survey

Wednesday, Nov. 29 11:10AM - 11:20AM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): To analyze the current status of the patient's safety culture and programs among the radiation oncology departments is Spain through a national survey.Materials/Methods: The survey was targeted to 98 heads of radiation oncology departments, both public and private. Each of them received a questionnaire and the responses were utilized to explore the study aim. Twenty five questions were asked on the following topics: Existence of a patient safety commission in his hospital and participation in the same of someone of the department; If someone in the department has tasks related to patient safety; Existence of maps of processes, risks and a risk probability scale; Check lists employment, Existence of a quality assurance program with indicators to measure the quality of each phase of the radiotherapy process, and when it was last updated; Performance of any external quality control audit; Existence of an anonymous and easy-access system of events notification; Number of adverse events reported in the last 12 months; Organization of regular meetings on issues related to patient safety; Existence of specific actions aimed at improving patient safety; Degree of implementation of the safety culture in its department and, finally, His opinion on the development and implementation by the Spanish Society of Radiation Oncology of an anonymous national system of notification of errors and incidents.Results: At present, 70 questionnaires have been received (participation rate 71.4%). Although 74% of the hospitals have a patient safety commission, only in 59% a radiation oncology staff is a member. In 70.3% of the departments some member has tasks related to patient safety. In the 88.8% there is a map of processes and in 40.7% a map of risks. In 85.1% check lists are used. In 100% of the departments there is a quality assurance program. In 66.6% some adverse effects were reported in the last year. Finally, almost all (96,2%) of the department's heads who responded agreed on the development and implementation by the Spanish Society of Radiation Oncology of an anonymous national system of notification of adverse events.Conclusion: The preliminary results of the survey show that, despite the fact that important work is being done on quality and of patient safety, there is still significant scope for improvement. Collection of questionnaires continues, and the final results will be presented and the final results will be presented when a participation rate of more than 80% has been achieved.

SSK19-07 Cost Effectiveness Analysis of Utilizing 3D Printer Technology to Create Bolus for Radiotherapy: An Institutional Experience

Wednesday, Nov. 29 11:30AM - 11:40AM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): At our institution, 3D printer technology is utilized in the radiation oncology department for constructing custom bolus. Bolus created using this innovative approach produces a more accurate fit in areas with complex skin contours and reduces air gap when compared to conventional bolus. It is also more convenient for patients and radiation therapists (RTs). As the use of 3D printing technology is expected to increase drastically in radiation oncology, we set out to perform a cost effectiveness analysis and report our findings. Materials/Methods: For the calendar year of 2014, patients who could have potentially had a bolus created using 3D printer technology at our institution were identified. Treatment sites included: sarcoma, anal canal, skin using orthovoltage energy and skin using electrons. Surveys were sent to 5 RTs to estimate the average time required to fabricate and set up a bolus using the conventional technique. Staff time required when using the 3D printer technique was estimated by an experienced physicist. Labour costs were determined for RTs, physicists and machinists, taking into account staff salary and labour hours. Cost of running and maintaining one linear accelerator and one orthovoltage unit was calculated. Cost of material required for 3D printer technique using polylactic acid (PLA) and cost of material using conventional technique was determined. Using the above information, total annual fabrication cost was calculated for both techniques. Total annual set up time was also calculated for both techniques. Potential annual cost savings were determined by subtracting the total annual cost of using the 3D printing method from the total annual cost of using the conventional method. Results: A total of 318 patients received 3204 fractions of radiotherapy. Cost of running the linear accelerator was $2.64/minute and $0.73/ minute for the orthovoltage unit. The cost of PLA was .07/cm3 and .11/cm3 for conventional bolus material. Taking into account the cost of our existing 3D printer, total annual accessory fabrication cost was $18,878.00 using the conventional method and $12,249.21 using 3D printer technology. Annual set up cost using conventional bolus was $71, 054.54, compared to $27,453.00 using 3D printer technology. When the two techniques were compared, potential annual cost saving were $47,678.53.Conclusion: This analysis, although not perfect, shows that by utilizing a simple consumer

grade 3D printer to create bolus for radiotherapy treatments, there can be substantial cost savings of just under $50,000.00 annually. When combined with the fact that 3D printed bolus provides a more accurate fit to the skin surface, provides equivalent or superior dosimetrics and adds patient and staff convenience, its usage is bound to become more common in radiation oncology departments. We recommend that utilization of 3D printer technology to create bolus for radiotherapy should become the new standard of care.

SSK19-08 Treatment Time Analysis of Radiotherapy for Breast Cancer Patients Treated with LINAC

Wednesday, Nov. 29 11:40AM - 11:50AM Room: S104A

Participants
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ABSTRACT

Purpose/Objective(s): To analyze setup time, beam on time and total treatment time of the radiotherapy treatment of breast cancer patients for case scheduling optimization, thus improving the machine throughput and the efficiency of treatment process Materials/Methods: In this study, breast treatment techniques of tangential opposing fields (2F), tangential opposing plus anterior SCF fields (3F) and tangential opposing fields with active breathing control (ABC) were considered. The total numbers of fraction in each case were 15-25. A customized table was used for recording setup time, beam on time and total treatment time for each patient. For 2F, 41 patients with 750 fractions were marked. For 3F, 8 patients with 163 fractions were marked. For ABC, 4 patients with 78 fractions were marked.The mean of setup time (TS), beam on time (TB) and total treatment time (TTx) for all fractions were calculated and compared among 2F, 3F and ABC techniques.To investigate treatment duration variability throughout the course of treatment, the mean of TS, TB and TTx of each fraction were also calculated and analyzed.One-way ANOVA was used in this study. Results: Mean (mins) TSTBTTx2F5.85.010.83F6.66.513.1ABC11.37.618.9The TS, TB and TTx among the three techniques were significantly different (pS between 2F and 3F due to similar setup procedures. In particular, the mean TS (11.3min) and hence TTx (18.9min) were much longer when using ABC technique. ABC device was needed to setup for controlling patient's respiratory motion which increased the total treatment time significantly.For treatment duration variability, the TTx for the first fraction was almost the double of overall fraction average regardless of the technique being used (190%, 208% and 217% for 2F, 3F and ABC respectively). It was due to setup verification performed during first treatment. For 2F and 3F, the TTxs in each fraction starting from second treatment were similar which the means were within 9-11mins. For ABC, the means TTxs of 2nd to 4th fractions were within 23-25mins which were still 30% longer than the average. This suggests 4 fractions were needed for patients to adapt the ABC setting and give stable performance throughout the remaining treatment course. The re-setup rate was low (3%) and only 0.3% patients felt uncomfortable and prolonged the treatment.Conclusion: Our current routine treatment time slot for 2F and 3F is 15mins while 30mins for the first fraction. For ABC, 45mins and 30mins are for first fraction and subsequent fractions respectively. This study suggested that the treatment duration of 2F for each fraction is 10mins and 20mins for first fraction. For 3F, it keeps 15mins as the average and 30mins for the first fraction. As for ABC, 40mins is suggested for the first fraction and 25mins for 2nd to 4th fractions while 20mins for the remaining fractions. The suggested case arrangement is expected to maximize the effective machine occupancy and hence the throughput.

SSK19-09 A Pilot Study to Evaluate a Newly-Developed Needs Assessment Tool for Improving Radiotherapy and General Oncology Management in Nigeria

Wednesday, Nov. 29 11:50AM - 12:00PM Room: S104A

Participants
Chika Nwachukwu, Stanford, CA (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Cancer mortality in low- and middle-income countries are rising at a rapid rate, especially in countries where screening programs are scarce and resources are limited. Fragmented infrastructure, as well as limited human resources hinder access to appropriate cancer care in these regions. The purpose of this study is to develop a tool that assesses the gaps in cancer care, with emphasis on radiotherapy infrastructure, personnel skill level, and barriers to accessing treatment.Materials/Methods: Stanford University has developed a detailed needs assessment tool, in collaboration with the American Cancer Society (ACS) and Clinton Health Access Initiative (CHAI). This tool will be tested in a cross sectional study at two teaching hospitals in Nigeria. Using this newly developed cancer assessment instrument, semi-structured interviews and onsite visits will be conducted to assess gaps in cancer care including radiotherapy infrastructure. Lastly, in collaboration with key hospital personnel, the results of this study will be used to finalize the assessment tool to ensure the local cancer care needs are adequately addressed. Results: The two hospitals sites, Ahmadu Bello University Teaching Hospital (ABUTH) and Lagos University Teaching Hospital (LUTH), were identified by the Nigerian ministry of health as two sites to be developed into comprehensive cancer centers. Both centers currently have chemotherapy delivery capacity, radiotherapy capacity (including linear accelerators, linacs), and are staffed by radiation oncologists, medical oncologists, and a small set of non-specialist clinical staff. Stanford experts have been paired with collaborators at ABUTH and LUTH. The needs assessment tool has two main components, a cancer assessment section and a human capacity section. The cancer assessment section has 6 broad areas ranging from summary and health status of the population to cancer specific needs. The different specialist from LUTH and ABUTH will complete the tool. There are 100 cancer specific needs questions, 20 of which focus directly on radiotherapy. The radiotherapy issues addressed include the demographics of patients receiving treatment (palliative or curative intent), referral patterns for patients, and barriers to care, such as cost of treatment. Furthermore, the tool assesses radiation treatment capacity to include availability of linacs, cobalt machines, brachytherapy machines and their functional capacities. Finally, the human resource section has 20 broad questions, many of which are applicable to radiotherapy staff, ranging from continuing education to the availability of staff, their respective roles, as well as their work flow. Conclusion: The completion of the needs assessment will take place during the site visit at the end of February. The results of the tool will be reported to identify actionable ways to improve cancer care, including the utilization of radiation in this setting.

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SSK20

Vascular Interventional (Embolization)

Wednesday, Nov. 29 10:30AM - 12:00PM Room: E351

IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

Thuong G. Van Ha, MD, Chicago, IL (*Moderator*) Research Grant, Cook Group Incorporated; Research Consultant, Surefire Medical, Inc
Nikunj R. Chauhan, MD, Cleveland, OH (*Moderator*) Nothing to Disclose

Sub-Events

SSK20-01 Efficacy of Transarterial Embolization in Managing Non-Variceal Gastrointestinal Bleeding Post-Endoscopy Failure: Systematic Review and Meta-analysis

Participants
Sanjay Bansal, MD, Calgary, AB (*Presenter*) Nothing to Disclose
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PURPOSE

Non-variceal gastrointestinal bleeding (NVGIB) is a common cause of hospitalization. In patients who have failed endoscopic therapy trans-arterial embolization (TAE) is considered the treatment of choice. The primary objective of this study is to perform a detailed systematic review and meta analysis of the current literature to assess (1) the success of TAE in controlling NVGIB, and (2) evaluate the mortality and morbidity rates post-TAE in patients for whom endoscopy has failed to control NVGIB.

METHOD AND MATERIALS

A search strategy was developed for EMBASE and Medline related to embolization and gastrointestinal bleeding using appropriate exploded medical subheading terms and keywords. Studies included were those examining patients presenting with a NVGIB whose bleeding could not be controlled with endoscopic intervention and subsequently were treated with TAE. The primary outcomes will be all-cause mortality and re-bleeding rates. These will be combined using a random-effects meta-analysis if sufficient data is extracted. Secondary outcomes will include length of hospitalization.

RESULTS

The search yielded 5624 articles from EMBASE and 2874 from Medline. After eliminating duplicates a total of 6421 were identified for further screening. Application of inclusion and exclusion criteria left a final total of 46 articles to be included in the study. Technical success was 97%. 24.65% of patients had bleeding within 30 days of TAE. 12.7% of patients required surgery after TAE. 30 day mortality post embolization was 22.8%. Bowel necrosis occurred in 3% of patients.

CONCLUSION

TAE in the setting of NVGIB, in which endoscopy has failed to control bleeding, is almost always successful acheiving cessation of contrast extravasation. 30 day re-bleed and mortality are high, however this may be confounded by pre-existing comorbidities and clinical instability of patients prior to undergoing embolization. Subgroup analysis will help to delineate this.

CLINICAL RELEVANCE/APPLICATION

In patients with NVGIB that is refractory to endoscopic therapy TAE should be strongly considered as an alternative to surgery as a second option. This is especially true in patients with multiple comorbidities, and/or patients that are clinically unstable, as they are high risk surgical candidates.

SSK20-02 Prostatic Artery Embolization: Identifying the Anatomical Variations in Origin of the Prostatic Artery and Predicting the Best Tube Angle Projection to Visualize its Origin Using Three Dimensional Contrast-enhanced MR Angiography

Wednesday, Nov. 29 10:40AM - 10:50AM Room: E351

Participants
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PURPOSE

To evaluate the ability of Three Dimensional Contrast Enhanced MR Angiography (3D-CE-MRA) in identifying the origin of the prostatic artery (PA) and predicting the best tube angle projection for its visualization before prostatic artery embolization (PAE) in an attempt to find a standard angle for its visualization during intervention

METHOD AND MATERIALS

Pre-embolization CE-MRA studies from 28 males (mean age 66.54 years) were retrospectively evaluated by two radiologists in consensus. Studies were done using a 3 Tesla MRI unit and 3D images were reconstructed using Syngo Vessel View Application. The PA was identified by tracing its course from the prostate back to its origin. Then the 3D figure was rotated in all directions to obtain the best visualization angle of the origin without overlap from other arteries

RESULTS

Of the studied 56 internal iliac arteries (IIA) the PA was detected in 80.1% (n=45); unilaterally in 17.9% (n=5 patients) and bilaterally in 71.4% (n=20 patients). It originated directly from the anterior division of the IIA in 57.78% (n=26), indirectly from the anterior division with a common trunk with other arteries in 13.33% (n=6, 3 with middle rectal, 2 with superior vesical and 1 with internal pudendal) and from different branches in 28.89% (n=13, 8 from internal pudendal, 3 from obturator and 2 from inferior gluteal). For the right PA (detected in 21 patients) the angle projection required for visualizing its origin ranged from 43° left to 45° right (mean 6.33° right +/- 30.4°). Additional cephalocaudal angulation was required in 66.67% (n=14) with angle ranging between 3° and 23° caudal (mean 11.79° caudal +/- 6.69°). For the left PA (detected in 24 patients) the angle projection required for visualizing its origin ranged from 45° left to 37° right (mean 16.04° left +/- 31.49°). Additional cephalocaudal angulation was required in 37.5% (n=9) with an angle ranging between 4° and 23° caudal (mean 13.67° caudal +/- 7.98°)

CONCLUSION

3D-CE-MRA can detect the origin of the PA before PAE and can predict the best tube angle projection to visualize it. There is no standard angle to visualize the origin that can be generally recommended; instead the angle should be individually tailored.

CLINICAL RELEVANCE/APPLICATION

3D-CE-MRA can identify the origin of the PA and predict the best tube angle projection to visualize it before PAE. The preplanning can reduce the need for searching for the origin using radiation during the procedure.

SSK20-03 Prostatic Arterial Embolization with Polyvinyl Alcohol Electrospun Nanofibers in a Canine Model of Benign Prostatic Hyperplasia (BPH): A Preliminary Study

Wednesday, Nov. 29 10:50AM - 11:00AM Room: E351

Participants
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PURPOSE

To explore the safety, feasibility and efficacy of embolization with polyvinyl alcohol (PVA) electrospun nanofibers in a canine model of benign prostatic hyperplasia (BPH).

METHOD AND MATERIALS

Five adult male beagle dogs (Beagle A, Beagle B, Beagle C, Beagle D, Beagle E) were included in this study. All beagle dogs were randomly numbered.The beagle dogs were castrated by an urologist. Intramuscular Benzylpenicillin (1,600,000 IU) was injected daily for three days to prevent infection. After one month, 2.5 mg/kg of TP were injected intramuscularly daily for 3 months. All beagle dogs underwent 3T MRI. The prostatic volume (PV) of all dogs was measured on MRI before and at 3 months after initiation of hormone administration. PAE was performed with superselective catheterization of the prostatic artery on each side through a femoral artery puncture after 3 months of TP therapy. Embolization was performed with the use of homemade 150-200 μm polyvinyl alcohol (PVA) electrospun nanofibers. All dogs was sacrificed 1 week, 1 month, 3 months, 6 months and 6 months after PAE, respectively. Histopathologic study was performed by the urologic pathologist.

RESULTS

The canine BPH model was successfully established in all dogs. The mean PV increased significantly after 3 months of hormone administration. DSA clearly depicted of the prostatic arteries after 3 months of hormone administration. PAE was successfully performed in all dogs. No serious PAE-related complication was observed during and after the procedure. In all five dogs, no significant abnormalities were found. Under the microscope, the PVA electrospun nanofibers in blood vessels with no spillover , mild inflammation in the prostate was found in Beagle A 1 week after PAE. The prostate of Beagle B 1 month after PAE showed cystic changes, atrophied gland, decreased inflammatory cells, more fibroblasts, focal hemosiderin deposition, and no evidence of neocapillarization. The parenchyma around the cavity showed atrophy under the microscope. In addition, focal hemosiderin deposition, scattered inflammatory cell infiltration, and fibrosis were found. Remnants of the glandular hyperplasia and embolic particles in blood vessels of the gland were present.

CONCLUSION

PAE with PVA electrospun nanofibers in a canine model of BPH is feasible, effective and safe.

CLINICAL RELEVANCE/APPLICATION

PVA electrospun nanofibers can be used in PAE

SSK20-04 Long-Term Clinical Outcomes and Re-Intervention Rates of Uterine Artery Embolization (UAE) For Symptomatic Fibroids or Adenomyosis: Five-Year Results

Wednesday, Nov. 29 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

To retrospectively investigate reintervention rates in patients treated with uterine artery embolization (UAE) for symptomatic fibroids or adenomyosis and to elucidate predictive factors for reintervention.

METHOD AND MATERIALS

Between March 2011 and February 2012, 124 patients who underwent UAE were categorized into fibroid group (n=92, 73.6%) or into adenomyosis group with or without fibroids (n=32, 26.4%). Five-year follow-up telephone survey was done to assess reintervention rates. Potential predictive factors for reintervention such as age, body mass index (BMI), as well as three-month follow-up magnetic resonance imaging (MRI) outcomes were analyzed.

RESULTS

Response rate to the telephone survey was 73.4 % (91/124, 67 fibroid and 24 adenomyosis). Technical success was achieved in all patients (100%). Overall reintervention rate was 11.0%, with seven patients in the fibroid group (10.4%) and three patients in the adenomyosis group (12.5%). Subgroup analysis of 15 adenomyosis patients without fibroids (i.e., pure adenomyosis) revealed three reintervention cases (3/15, 20.0%). Reinterventions in the fibroid group were myomectomy (n=5) and hysterectomy (n=2). Among 56 patients with available follow-up MRI, 54 (96.4%) had complete necrosis of the predominant fibroids. One patient with cervical leiomyoma had treatment failure resulting in hysterectomy. Reinterventions in the adenomyosis group were hysterectomy (n=2) and myomectomy (n=1). 13 out of 15 follow-up MRIs of adenomyosis patients with or without adenomyosis (86.6%) demonstrated complete necrosis, resulting in one case of hysterectomy. One of two adenomyosis patients without necrosis (1/15, 13.3%) underwent hysterectomy. In the adenomyosis group, there was a trend towards lower reintervention rate in patients with complete necrosis than in those without necrosis, but without statistical significance.

CONCLUSION

Reintervention rates in fibroid and adenomyosis groups at five years were 10.4% and 12.5%, respectively. Low reintervention and high clinical success rates strengthen the potential of UAE as a viable first line treatment for symptomatic fibroid or adenomyosis.

CLINICAL RELEVANCE/APPLICATION

Uterine artery embolization(UAE) has strong potential as first line treatment for adenomyosis with or without fibroids with low reintervention rate and high clinical success rate.

SSK20-05 Refinements of Preoperative Portal Vein Embolization Using Ethylene-Vinyl Alcohol Copolymer: A Pilot Study

Wednesday, Nov. 29 11:10AM - 11:20AM Room: E351

Participants
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PURPOSE

To evaluate the safety profile and the added value ethylene-vinyl alcohol copolymer (Onyx) injection for selective embolisation of specific portal branches during of preoperative portal vein embolisation (PVE).

METHOD AND MATERIALS

From 2008 to 2011, 110 PVE procedures were performed in our hospital in patients with small future liver remnants (FLR). Under general anaesthesia, PVE was achieved with injection of a mixture of n-butyl-cyanoacrylate (Histoacryl) and iodised oil (Lipiodol) using a 5-F catheter. At the operator's discretion, small portal branches with a great risk of embolic agent migration were embolised with Onyx through a 2.4-F microcatheter. CT volumetry of the FLR was performed before and 4-6 weeks after PVE. Clinical outcome was assessed on medical records.

RESULTS

Twenty-eight patients (median age, 57±17 years) underwent PVE with Histoacryl-Lipiodol and additional Onyx during 29 procedures. The indications for Onyx were embolisation of segment IV (n=21), early bifurcation of portal branches in S6 and S8 (n=5) and PVE in a one-year-old girl with cystic mesenchymal hamartomas. All targeted portal branches were successfully embolised with Onyx and no major complication was observed. Related-procedure adverse events included a self-limited subcapsular haematoma (3%) and two small pieces of glue migration without thrombosis (7%). CT volumetry showed a mean FLR hypertrophy of 64±28%. Hepatectomy was performed in 25 patients (89%) and cancelled in three patients, due to tumour progression (n=2) or insufficient FLR volume (n=1).

CONCLUSION

PVE with complementary Onyx before liver resection is safe and feasible, and helps to occlude small portal branches that are not accessible with conventional embolic materials.

CLINICAL RELEVANCE/APPLICATION

PVE with complementary Onyx before liver resection is safe and feasible, and helps to occlude small portal branches that are not accessible with conventional embolic materials.

SSK20-06 Emergency Out of Hours Endovascular Hemorrhage Control Procedures: Evolution of Caseload, Casemix and Clinical Outcome between 2009 and 2014

Wednesday, Nov. 29 11:20AM - 11:30AM Room: E351

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Demand for emergency OOH EVHC procedures is increasing. The most dramatic and urgent cases are those in which IR undertake minimally invasive EHCPs where surgery is physiologically undersirable or technically challenging. We analyzed the changing caseload, casemix and 30-day mortality for emergency OOH EVHC procedures performed in 2009 and 2014 with hopes to inform service design, training and clinical decision making.

METHOD AND MATERIALS

The setting was four centers providing OOH IR services for a population of 3 million. Data related to all OOH EVHC done in 2009 and 2014 were analyzed, including mortality within 30 days of the index procedure. Procedures were categorised by site and etiology of hemorrhage and by whether or not a therapeutic intervention was actually performed.

RESULTS

Between 2009 and 2014: 1. The annual total caseload increased by 40% from 93 to 130 procedures ($P<0.05$), a per capita increase in caseload from 3.1 to 4.3 per 100,000 population 2. The number of therapeutic procedures increased by 34% from 84 to 113 3. Changes in casemix included significant increases in numbers of lower gastrointestinal (GI), non-surgical iatrogenic etiologies and spontaneous hemorrhage 4. The number of upper GI cases and postoperative bleeding was unchanged 5. The number of post-partum haemorrhage (PPH) cases was significantly reduced 6. 30-day mortality significantly increased from 9% to 18% ($P< 0.05$) 7. Patients in the 2014 cohort were significantly older, mean age (range) 60.6 years (19-94) vs. 52.3 (19-91), ($P<0.05$)

CONCLUSION

Increasing demand for emergency OOH EHVC procedures was accompanied by increased caseload of lower GI, non-surgical iatrogenic and spontaneous hemorrhage, with fewer PPH cases. Speculation on reasons for changes creates interesting discussion points. The older patients in the 2014 cohort suggests that the observed increase in mortality rate is likely attributable to changing referral thresholds (e.g. more patients with co-morbidities and/or in greater physiological distress). Identifying these trends facilitates service design, effective training and clinical decision-making.

CLINICAL RELEVANCE/APPLICATION

Analysis of changing caseload and casemix of out-of-hours (OOH) endovascular hemorrhage control (EVHC) procedures facilitates efficient service design, effective training and informed clinical decision-making

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ian A. Zealley, MBChB - 2016 Honored Educator

SSK20-07 Stent Graft Implantation in Visceral Arteries in Acute Life-Threatening Hemorrhage after Upper Abdominal Surgery: Technical Results and Clinical Outcome

Wednesday, Nov. 29 11:30AM - 11:40AM Room: E351

Participants
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Christoph K. Thomas, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Vascular erosion of the major visceral arteries (e.g. hepatic artery) due to leaking of pancreatic or jejunal anastomses is a rare but severe complication after upper abdominal surgery, leading to life-threatening delayed intraabdominal bleeding. Due to multiple risk factors and comorbidities, surgery is not always possible, making an interventional approach desireable. However, in major visceral arteries like the hepatic or superior mesenteric artery, vessel patency has to be preserved to prevent organ necrosis; thus a stent graft has to be implanted. The purpose of the present study was to analyze technical and clinical outcome after heparin-bonded stent graft placement to treat acute hemorrhage of the visceral arteries after surgery.

METHOD AND MATERIALS

A retrospective analysis of 22 male and 7 female patients (mean age: 66 years) who underwent heparin-bonded stent graft placement for the treatment of post surgical bleeding between 2009 and 2016 was performed. An explorative data analysis concerning technical success, complications as well as short term survival (<30 days) and long term survival (<90 days) was performed.

RESULTS

Successful stent graft placement and vessel reconstruction could be achieved in 24 of all 29 patients (83%). Surgical conversion was necessary in five patients. Periinterventional complications could be observed in six patients (vasospasms: n=4; pseudoaneurysm perforation: n=1; reversible stent occlusion: n=1). In 13 patients, a total of 14 stent graft related complications could be observed after the intervention (re-bleeding: n=7; stent graft occlusion: n=7), access related complications were observed in three patients. Short term survival was 76% (n=22) and long term survival was 41% (n=12), with most causes of death related to the underlying surgical complication.

CONCLUSION

Endovascular treatment of post-surgical bleeding using heparin-bonded stent grafts is a feasible treatment option with a high technical success rate. However, multiple risk factors and comorbidities in this specific patient cohort lead to a high complication rate and a comparably low long term survival rate.

CLINICAL RELEVANCE/APPLICATION

In patients with delayed intraabdominal bleeding after surgery, endovascular treatment using heparin-bonded stent grafts is a possible treatment option with a high technical success rate.

SSK20-08 Unenhanced MRI of the Pulmonary Vasculature Allows for Detection of Pulmonary AV-Malformations (PAVM) in Patients with Hereditary Hemorrhagic Telangiectasia (HHT / Osler's Disease)

Wednesday, Nov. 29 11:40AM - 11:50AM Room: E351

Participants
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Guenther K. Schneider, MD, PhD, Homburg, Germany (*Abstract Co-Author*) Research Grant, Siemens AG; Speakers Bureau, Siemens AG; Speakers Bureau, Bracco Group; Research Grant, Bracco Group;

PURPOSE

To compare the detection rate of pulmonary AV-Malformations (PAVMs) in Gd-enhanced MR angiography with unenhanced MR imaging techniques in patients with hereditary hemorrhagic telangiectasia (HHT).

METHOD AND MATERIALS

During this retrospective Study 122 patients with HHT underwent a total of 188 MR examinations between 01/2011 and 12/2015. The patients' age varied from 11 to 83 years (mean 48 years). Each examination included a non contrast enhanced SPACE (3D TSE-sequence/ TR 4.733 ms/ TE 101 ms/ FLIP 150°) and a contrast enhanced 3D GRE MRI sequence (TR 2,87ms/ TE 1,07 ms/ FLIP 25°, 0.1 mmol/kg BW MultiHance). Both examinations were read by two experienced radiologists and the number of detected AV-Malformations was reported in agreement for each examination. The contrast enhanced images were always read first and after an blanking interval of 6 weeks, the SPACE was read by the same radiologists; blinded to the results of the first reading. In cases in which therapy was required, catheter angiography was used as a gold standard and in all other cases CE-MRA served as the gold standard. A paired t-test was utilized for statistical evaluation.

RESULTS

4 Examinations had to be excluded due to respiratory artifacts in both sequences. 60 AV-malformations requiring therapy were reported in 35 patients. Using contrast enhanced images, an overall significantly higher number of AV-malformations was detected (166 vs. 96, p<0.001) but none of the AV-malformations requiring therapy (supporting vessel larger than 2 mm) were missed using the unenhanced SPACE sequence.

CONCLUSION

By using a SPACE sequence, the detection of clinical relevant pulmonary AV-malformations in patients with HHT can be safely performed in patients with contraindications for i.v. contrast medium (e.g. pregnancy).

CLINICAL RELEVANCE/APPLICATION

In patients with HHT it is important to find clinically relevant pulmonary AV-malformations, and using the SPACE sequence these can be found even in Patients with contraindications to contrast enhanced MRI.

SSK20-09 High Temporal Resolution Dynamic CE MRA in Detection of Reperfused Pulmonary Arteriovenos Malformations (PAVMs) in HHT-Patients

Wednesday, Nov. 29 11:50AM - 12:00PM Room: E351

Participants
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Arno Buecker, MD, Homburg, Germany (*Abstract Co-Author*) Research Grant, Siemens AG Consultant, Bracco Group Speaker, Bracco Group Consultant, Medtronic plc Speaker, Medtronic plc Research Grant, Novartis AG Research Grant, GlaxoSmithKline plc Research Grant, Biotest AG Research Grant, OncoGenex Pharmaceuticals, Inc Research Grant, Bristol-Myers Squibb Company Research Grant, Eli Lilly & Company Research Grant, Pfizer Inc Research Grant, F. Hoffmann-La Roche Ltd Research Grant, sanofi-aventis Group Research Grant, Merrimack Pharmaceuticals, Inc Research Grant, Sirtex Medical Ltd Research Grant, Concordia Healthcare Corp Research Grant, AbbVie Inc Research Grant, Takeda Pharmaceutical Company Limited Research Grant, Merck & Co, Inc Research Grant, Affimed NV Research Grant, Bayer AG Research Grant, Johnson & Johnson Research Grant, Seattle Genetics, Inc Research Grant, Onyx Pharmaceuticals, Inc Research Grant, Synta Pharmaceuticals Corp Research Grant, Siemens AG Research Grant, iSYMED GmbH Research Grant, St. Jude Medical, Inc Co-founder, Aachen Resonance GmbH

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PURPOSE

The recommended treatment of PAVMs in HHT patients (Hereditary Hemorrhagic Telangiectasia / Osler disease) is catheter embolization either with coils or by the use of vascular plugs. Although immediate post-interventional imaging may show complete success of embolization therapy, reperfusion may occur due to opening of collateral vessels or reperfusion of the embolized vessel itself. The aim of our study was to evaluate time-resolved contrast-enhanced MR-Angiography for detection of reperfused PAVM.

METHOD AND MATERIALS

65 patients in which treatment of PAVMs by means of platinum coil embolization or implantation of Amplatzer vascular plugs was performed, underwent follow-up studies for detection of reperfused PAVM by contrast enhanced MRA. First, a time-resolved MRA-study was performed with injection of a small contrast medium bolus (0.025 mmol/kg BW (Gd-BOPTA) MultiHance, Bracco). The temporal resolution of the sequence was 3 sec / dataset with a total number of 72 slices. Thereafter a high resolution CE MRA (0.075 mmol/kg BW MultiHance) with a timing based on the findings from the time resolved study was performed. Images were evaluated regarding enhancement of the draining vein. Recanalization was diagnosed when a simultaneous enhancement of feeding artery and draining vein or aneurysm sac was observed on dynamic CE MRA.

RESULTS

Time-resolved MR-Angiography was technically adequate in 61 of 65 cases. In 26 out of the 61 patients diagnosis of 32 reperfused PAVMs was made. In those cases in which diagnosis of reperfused PAVM was unclear on high resolution images, evaluation of the enhancement kinetics of the draining vein on dynamic CE MRA was used for diagnosis and could confirm 14 reperfused PAVM. All reperfused PAVM diagnosed on CE MRA were confirmed by DSA and underwent reembolization.

CONCLUSION

Time resolved contrast-enhanced MR-Angiography is a helpful adjunct to standard high resolution anatomic imaging, allowing for the evaluation of the enhancement kinetics of the draining vein as an indicator of recanalization of PAVM. Compared with CT imaging of embolized PAVM, this is an important advantage of CE MRA.

CLINICAL RELEVANCE/APPLICATION

Reperfusion of PAVM can occur in up to 20 percent of cases and early detection is mandatory to avoid complications. Dynamic CE MRA directly depicts early enhancement of the draining vein as a sign of reperfusion and thus gives important information not gained in conventional acquisitions.

MSRO43

BOOST: Lymphoma, Pediatrics, Sarcoma-Science Session with Keynote

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S103CD

PD RO OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Hui-Kuo G. Shu, MD, PhD, Atlanta, GA (*Moderator*) Speakers Bureau, Varian Medical Systems, Inc; Stockholder, General Electric Company; Stockholder, Medtronics plc; Stockholder, Mylan NV ; Stockholder, Apple Inc; Stockholder, ICON plc
Yolanda D. Tseng, MD, Seattle, WA (*Moderator*) Nothing to Disclose

Sub-Events

MSRO43-01 Invited Speaker:

Wednesday, Nov. 29 1:30PM - 1:40PM Room: S103CD

Participants
Yolanda D. Tseng, MD, Seattle, WA (*Presenter*) Nothing to Disclose

MSRO43-02 Identifying Radiation Induced Brain Abnormalities in Adult Survivors of Pediatric Brain Tumor from "Normal-Appearing" MRI Using a Machine Learning Approach

Wednesday, Nov. 29 1:40PM - 1:50PM Room: S103CD

Participants
Leonardo Tang, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Silun Wang, MD, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose
Liya Wang, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Hui Mao, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Radiation treatment may cause long-term adverse effects on brain tissue and cognitive function in pediatric brain tumor patients. The aim of this study is to use machine learning methods to search and extract the possible radiation induced abnormalities from the MRI data of a patient cohort, and further to characterize radiation-induced neurodegenerative effects on white and gray matters.

METHOD AND MATERIALS

14 adult survivors of pediatric brain tumors (with median radiation dose of 5400 cGy) who undergone extensive radiation treatment (RT) and demographically matched healthy controls (mean age: 22.7 ± 4.5 vs. 22.9 ± 4.3, $p>0.05$) were enrolled in the study. MPRAGE images used in this study were acquired with TR/TE = 2250/4ms, slice thickness = 1 mm, FOV = 256 mm2. All MRI data were preprocessed based the scheme shown in Figure 1 using the Statistical Parametric Mapping (SPM12) software package. Machine learning analysis was conducted using the Pattern Recognition for Neuroimaging Toolbox (PRoNTo) and run on GM and WM separately. The data were mean-centered and a Gaussian Processes Regression (GPR) model was defined using age as the dependent variable and the similarity matrix of imaging data as the independent variables.

RESULTS

The GPR model successfully differentiated the RT and controls with diagnostic accuracy of 100% in both white matter and gray matter analysis. Figure 2 shows the weighted display indicating the specific regions in WM and GM exhibiting the abnormalities in RT subjects comparing to the controls, which contribute to this classification of RT and control. In weighted display in WM, frontal lobe WM (i.e., anterior corpus callosum) contributes to the largest difference between RT and control (deep blue area), which is consistent with our previous results based on the analysis of diffusion tensor images (Wang, et al, 2015, PLOS One). However, in weighted display in GM, there is no specific region that exhibits the difference or contributes to the classification

CONCLUSION

Machine learning based method and model for predicting radiation induced neurodegenerative effect on adult survivor of brain tumor patient led to the successful identification of the abnormal regions in the brain of RT patients using just T1 weighted MPRAGE.

CLINICAL RELEVANCE/APPLICATION

Further development and application of this approach will enable integrated use of machine-learning assisted radiological assessment of treatment effect.

MSRO43-03 Profiling Myxofibrosarcoma: Patient and Disease Characteristics as Well as Clinical Outcomes at a Major Tertiary Care Cancer Center

Wednesday, Nov. 29 1:50PM - 2:00PM Room: S103CD

Participants

Gaurav Bhattacharya, Ottawa, ON (*Presenter*) Nothing to Disclose
Matthew` Tsang, MSc, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose
Horia Marginean, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose
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ABSTRACT

Purpose/Objective(s): Formerly known as a myxoid variant of malignant fibrous histiocytoma (MFH), myxofibrosarcomas occupy their own niche in the World Health Organization classification in the category of fibroblastic and myofibroblastic tumors. With a predisposition for the elderly, they possess a high post treatment local recurrence rate. We take a close look at this soft tissue sarcoma subtype to highlight the incidence as well as outcomes at our large teaching hospital. Materials/Methods: A retrospective chart review was first undertaken to identify myxofibrosarcoma patients over a 10 years span from 1/2005 to 1/2015 with follow up data through to 2/2017 to guarantee at least 2 years of post-treatment data from a pool of aggregated soft tissue sarcoma tumors. Information was gathered via Electronic Medical Records, paper charts and communication with peripheral facilities and family physicians' offices. Sole inclusion criterion was histologic disease confirmation in patients aged = 18. A comprehensive literature review was also undertaken to determine current developments for this histology. Overall survival was analyzed using Kaplan-Meier methodology. Results: Thirty nine patients meeting selection criterion were selected from a total of 968 entries. With a largely male incidence (61.5%), the most common presenting symptom was a painless mass (95%). Median age was 62 years with a median follow up of 45 months. Commonest occurrence was in the extremities and superficial trunk (82%) with a median tumor size of 9.5 cm. Grade 2 disease at 41% was followed by 20.5% for both Grade 1 and 3 diseases according to the FNLCC (Federation Nationale des Centres de Lutte Contre le Cancer) system. Median pre-treatment hemoglobin post diagnosis was 12.8 g/dL. Curative intent treatment was offered in 87% of cases; with surgery in 92% of cases, being the primary modality of treatment. Radiation therapy (median fractionation of 50 Gy in 25 fractions) and chemotherapy were provided in 74% and 18% of cases respectively, primarily in an adjuvant setting for curative intent patients.Post-surgical margins were positive in 22% of patients and lymphovascular invasion identified in only 2 cases. Median time from diagnosis to initiation of primary treatment was 30 days with median time from radiotherapy start to end being 35 days. Sixty percent of curative intent patients receiving radiation had Three-dimensional Conformal Radiotherapy (3D-CRT) planning.Stage distribution by incidence was: Stage I 18%, Stage II 49%, Stage III 21% and Stage IV 10%. Thirty six percent of patients had a recurrence or disease progression with only 4 having a local component. Of the 11 patients who had a recurrence, 8 were stage II and 3 were stage III. Overall, three and five year overall survival estimates were 70% and 67% respectively.Conclusion: Treatment outcomes for myxofibrosarcoma remain relatively good at our large tertiary cancer centre. More research is required to identify strategies in enhancing both locoregional and systemic control.

MSRO43-04 Local Control in Pediatric Adolescent Meningiomas Treated with Proton Radiotherapy

Wednesday, Nov. 29 2:00PM - 2:10PM Room: S103CD

Participants
Anne Sailer, Boston, MA (*Presenter*) Nothing to Disclose

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ABSTRACT

Purpose/Objective(s): Pediatric meningiomas comprise less than 5% of pediatric CNS tumors. Limited pediatric data indicate that extent of surgical resection and tumor grade are strong prognostic factors for relapse free survival, but little data exists on the efficacy of radiotherapy in pediatric meningioma. Here we report the outcomes of pediatric meningioma patients treated with proton radiotherapy (PRT), which was used to minimize late effects of treatment. Materials/Methods: Eighteen patients were treated with PRT from 2005-2015 at our institution. Histologic WHO grade distribution was as follows: seven grade I, (38.8%, one with atypical features); 10 grade II (55.6 %), one grade III (5.6%). Fifteen patients had gross disease at the initiation of PRT. Three patients (with grade II or III tumors) had no visible disease at the time of PRT. The median PRT dose was 54 GyE, delivered in 1.8 GyE fractions (range, 50.4-63.4 GyE). The radiographic response of gross tumor was measured by a change in tumor volume after PRT. Clinical outcome including disease control and toxicities were reviewed and graded according to CTCAE v4.0.Results: The median follow-up time was 4.0 years with an estimated 5-year DFS and Local control rate of 100%. However one patient died from causes unrelated to disease or treatment. Eight of 15 pts with gross disease at PRT (53.3%) had decreased tumor size after PRT treatment; six (33.3%) had stable disease; and one was lost to follow up. Sequelae from treatment were minor and affected 8 of 17 patients and include: Moyamoya disease (5.6%; successfully treated), chronic headaches (18.7%), occasional grade 1-2 headaches (16.7%), radiation retinopathy (5.6%), and central endocrine deficit (11.1%). Patients who experienced hearing loss, vision loss, or seizures after PRT had these conditions at baseline prior to PRT. The mean CTV volume for patients with and without late toxicities was 41.8 cc (6.7–107.7) vs. 46.9 cc (1.7-157.4). Tumor location in the anterior cranial fossa, sphenoid wing, and optic canal were correlated with late side effects compared with other intracranial regions. Tumors near the cavernous sinus, the circle of Willis, or optic nerves were associated with the most co-morbidities at baseline.Conclusion: PRT is both safe and effective in treating pediatric meningioma. Further follow up is needed to determine if gross residual disease at the time of radiation diminishes disease control. Tumor location was more correlated with side effects than target volume.

MSRO43-05 Early Experience with Unidirectional Planar Brachytherapy for IORT of Abdominal Malignancies

Wednesday, Nov. 29 2:10PM - 2:20PM Room: S103CD

Participants
Heming Zhen, PhD, Boston, MA (*Presenter*) Nothing to Disclose
Julius Turian, PHD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Minh B. Luu, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Neilayan Sen, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
James C. Chu, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Ross A. Abrams, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
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ABSTRACT

Purpose/Objective(s): Recently, an innovative unidirectional Pd-103 low-dose-rate brachytherapy device, CivaSheet (CivaTech Durham, NC) has been developed as a promising IORT tool. The purpose of this study is to report our initial clinical experience using this new IORT technology to boost the tumor bed after preoperative radiotherapy and resection of abdominal malignancies. The positional stability of device following its placement is investigated using sequential post-implant CT scans.Materials/Methods: The CivaTech IORT was utilized to boost the tumor bed after resection of abdominal malignancies in two patients (recurrent retroperitoneal liposarcoma and recurrent gastric adenocarcinoma, respectively). Prior to surgery each patient underwent a CT simulation for IORT boost dosimetry planning. PTV predicted for high risk recurrence after resection were delineated via a joint effort between the radiation oncologist and the surgeon. Eclipse Treatment Planning System (Varian, Palo Alto, CA) was used for dosimetry planning. For patient 1, a 5 x 15 cm2 (108 dots, 0.8 U/dot) sheet was chosen, to prescribe 25 Gy to at least 90% of the PTV. For patient 2, a 5x10 cm2(66 dots, 0.62 U/dot) was chosen to prescribe 26 Gy to at least 90% of the PTV. Each patient underwent a successful resection of intra-abdominal malignancy. Since the Pd-103 radioactive dots are held in a spatial matrix (8 mm spacing) by a bio-absorbable membrane, with a 6 weeks onset to absorption, the positional stability of the device was investigated using post implant sequential CT scans. Dosimetric evaluation was done on CT scans acquired at specific time intervals. Results: The CivaSheet was successfully placed over the tumor bed PTV with its gold face up, which spares any normal tissue structures on top from high dose irradiation. Absorbable stitches were used to secure the device. The CivaSheet placement added 10-12 min of operative time. Postoperative recovery was uneventful for both patients. Patient 1 had CT scans at 2.5 weeks (Pd-103 T1/2 = 17 days) and 3 months post implant. Patient 2 had CT scans at 1 week and 6 weeks post implant. For both patients, all seeds were detected in the tumor bed, without regional or distant migration. A slight trend toward seed clustering was noticed on the 3 months scan for patient 1, but not on the 6 weeks scan for patient 2. PTV dosimetric coverage analysis showed D90 =25.5 Gy (102% Rx) and 29 Gy (116% of Rx) for the two post implant CT scans for patient 1. For patient 2 D90=26 Gy (100% Rx) and 28 Gy (108% Rx) was shown for the two post implant CT scans. No patient experienced complications related to CivsSheet placement or its postoperative presence.Conclusion: We found that the unidirectional CivaTech planar brachytherapy device is safe, suitable and versatile for the treatment of abdominal malignancies. CT dosimetry demonstrated no significant device movement or seed migration, while PTV coverage was well maintained up to 3 months post implant.

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SSM01

Breast Imaging (Practice Issues)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451A

BR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Jocelyn A. Rapelyea, MD, Washington, DC (*Moderator*) Speakers Bureau, General Electric Company;
Jessica W. Leung, MD, Houston, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSM01-01 A Monte Carlo Simulation: Impact of new USPSTF on Breast Cancer Screening on Ages 40-49 across the USA

Wednesday, Nov. 29 3:00PM - 3:10PM Room: E451A

Awards
Student Travel Stipend Award

Participants
Akshay Goel, MD, New York, NY (*Presenter*) Nothing to Disclose
Ralph T. Wynn, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Richard S. Ha, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess the potential implications of the United States Preventive Services Task Force (USPSTF) for women ages 40-49 in the United States.

METHOD AND MATERIALS

This is an IRB exempt study based on a literature review of multiple factors related to breast cancer screening. Based on the US consensus data, we determined the total number of women between ages 40-49. A Monte Carlo simulation model was tailored to fit our study design, specifically to assess the potential impact of USPSTF guidelines on cost and mortality. We randomized the patients into two groups: A) annual screening starting at age 40 per traditional guidelines vs. B) annual screening starting at age 50 per USPSTF guidelines. Data points from large randomized control trials and the literature were utilized as parameters in our model to predict mortality events, and biopsy events (core biopsy, fine-needle-aspiration). These parameters included: absolute morality A) 0.29% B) 0.36%, medical costs of metastatic breast cancer: $120,000, cost per mammogram: $75, and various procedure parameters for fine-needle aspiration and core biopsy. Cost analysis did not include indirect societal and nonmedical costs related to loss of life in a relatively young cohort. Differences in mortality and overall cost were assessed using a two-sided Student's t test.

RESULTS

We determined the cohort size of women ages 40-49 from the US census data to be approximately 20 million. Using our model, we ran our simulation on a cohort of 20 million patients. In the traditional screening group there were 29342 deaths. This was significantly higher compared to the USPSTF non-screening group, which had 36222 deaths ($p < .001$). In the traditional screened group the average cost per patient was $622. This was higher compared to the USPSTF non-screening group average cost of $438 ($p < .001$).

CONCLUSION

The USPSTF guidelines result in increased mortality for non-screened patients between ages 40-49. The higher average cost per patient in the screened group however may not be clinically significant, when societal and nonmedical mortality costs are taken into account.

CLINICAL RELEVANCE/APPLICATION

Breast cancer screening remains a controversial topic and further work is needed to help patients and clinicians understand new guideline implications on patients between ages 40-49.

SSM01-02 Screening Mammography Audit Metrics Differ Depending on the Reference Standard Used: Systematic Performance Underestimation and a Solution

Wednesday, Nov. 29 3:10PM - 3:20PM Room: E451A

Participants
Elizabeth S. Burnside, MD, MPH, Madison, WI (*Presenter*) Nothing to Disclose
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PURPOSE

Cancer detection rate (CDR), an important screening mammography audit metric, can be determined using two different reference standards: (1) biopsy results (CDR_B)-widely used by U.S. practices or (2) registry-match (CDR_R)-used in published benchmarks. The purpose of this study was to determine CDR performance based on these two reference standards, which are both available in our practice, and to develop a conversion algorithm for practices using biopsy results when registry data is not available.

METHOD AND MATERIALS

Using consecutive screening mammograms (1/1/2006 to12/31/2013) from a single institution academic breast imaging practice, we calculated CDR_B and CDR_R according to BI-RADS definitions. We compared the outcomes (per year and in aggregate) using McNemar's test. We calculated ascertainment rate (AR)-defined as the fraction of biopsies performed (B_perf) of the number recommended (B_rec)-to reconcile the difference between CDR_B and CDR_R. Finally, we developed an algorithm with 95% confidence intervals to estimate CDR_R (CDR_R-est) using CDR_B.

RESULTS

For 83,895 consecutive screening mammograms, we found the overall CDR_B of 4.79/1000 significantly underestimated the CDR_R of 5.09 ($p < 0.001$), despite a relatively high AR of 89.0%-Table; a pattern of underestimation that was systematically re-demonstrated for each year. We developed a conversion algorithm based on data elements (e.g. positive predictive value of biopsy performed-PPV3) typically available in practices without a registry match: CDR_R-est = CDR_B + (((B_rec-B_perf)*PPV3)/# of screening mammograms), for which the confidence interval contained the observed CDR_R for each year and all years in aggregate.

CONCLUSION

Cancer registry-matching, is onerous, costly, difficult to implement, and therefore not used routinely in practice. The existing guidelines to use CDR_B can significantly underestimate CDR and may lead to erroneous conclusions about performance, thus a conversion algorithm providing an accurate range accounting for practice-level AR, is important to avoid CDR underestimation and promote more accurate comparisons across clinical practices.

CLINICAL RELEVANCE/APPLICATION

Because most practices use biopsy results, not registry-matching as reference standard, systematic underestimation of CDR is likely; a problem addressed by the conversion algorithm that we propose.

SSM01-03 County-level Factors Predicting Low Uptake of Screening Mammography

Wednesday, Nov. 29 3:20PM - 3:30PM Room: E451A

Participants
Samantha L. Heller, MD, PhD, New York, NY (*Presenter*) Nothing to Disclose
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Yiming Gao, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The purpose of this study is to investigate county-level geographic patterns of mammographic screening uptake throughout the United States and to determine the impact of rural vs. urban settings on breast cancer preventive services.

METHOD AND MATERIALS

This descriptive study used a de-identified aggregate dataset, the County Health Rankings (CHR), to identify the percent of Medicare enrollees age 67-69 per US county having at least one mammogram in 2013. This uptake was matched with U.S. Department of Agriculture Rural Atlas (USDARA) data categorizing counties as metropolitan vs. non-metropolitan and along an urban continuum scale (1-9) based on county population size (large defined as population >= 20,000; small <20,000) and metropolitan proximity. Univariable and multivariable analyses were performed using SAS 9.3 software.

RESULTS

2,243,294 Medicare beneficiaries aged 67-69 were eligible for mammograms. Mean mammographic uptake per county was 60% (range 26%-86%). Uptake was significantly higher for metropolitan vs. non-metropolitan counties in 19 states, significantly lower in 4 states, and not significantly different in the remainder. Uptake was significantly higher for large counties in 25 states and

significantly lower in only 1 state. County-level mammographic uptake was positively correlated with the number of Medicare enrollees (r=+0.27, p<0.001), % white residents (r=+0.16, p<0.001), income level (r=+0.34, p<0.001), and % of residents with some college education (r=+0.40, p<0.001), and negatively correlated with ratio of population to primary-care providers (PCP) ratio (r=-0.31, <0.001), age-adjusted mortality (-0.41, p<0.001), and % Hispanic residents (-0.11, p<0.001). Multivariable analysis demonstrated that the % of white and black residents, income level, PCP ratio, mortality rate, and % of non-English proficient residents were significant independent predictors of mammographic screening uptake.

CONCLUSION

Uptake of mammographic screening services varies widely at the county level and is lower in less metropolitan counties and in counties with smaller populations.

CLINICAL RELEVANCE/APPLICATION

In conjunction with predictive factors such as income, race, and primary care access, county-level geographic categorizations may help identify communities needing breast cancer screening education.

SSM01-04 Attitudes Towards Mobile versus Fixed Facility Preferences for Obtaining a Mammogram Among Latinas

Wednesday, Nov. 29 3:30PM - 3:40PM Room: E451A

Awards
Student Travel Stipend Award

Participants
Allison A. Tillack, MD, PhD, Seattle, WA (*Presenter*) Nothing to Disclose
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PURPOSE

Mobile mammography services have been proposed as a way to increase Latinas' screening mammography rates and reduce their disproportionate late-stage presentation compared to White women. However, our recent study suggested that this service may not significantly increase their screening rates. This study evaluates potential reasons why Latinas may not use mobile mammography services and evaluates changes in their preferences after using these services.

METHOD AND MATERIALS

Using a mixed methods approach, we conducted a secondary analysis of survey data (n=538) from a randomized controlled trial to improve screening mammography rates among Latinas in Washington. Descriptive statistics and bivariate regression were used to characterize mammographic location preferences, and to test for associations with demographic factors such as sociodemographics, healthcare access, and perceived breast cancer risk and beliefs. Based on these findings, a qualitative study (n=18) was used to evaluate changes in perceptions after using mobile mammographic services.

RESULTS

More Latinas preferred obtaining a mammogram at a fixed facility (52.3%, n=276) compared to having no preference (46.3%, n=249) and mobile mammography services (1.7%, n=9). Concern about privacy and comfort (15.6%, n=84), having multiple reasons (13.2%, n=71) and concerns about general quality (10.6%, n=57) were common reasons for preferring a fixed facility. Only a history of a prior mammogram was significantly associated with having no mammogram location preference (P<0.05). In the qualitative study, Latinas expressed similar initial concerns about the quality and privacy and comfort of the mobile mammography service, however, became positive towards the mobile mammography services after having a mammogram.

CONCLUSION

While most Latinas preferred obtaining a mammogram at a fixed facility because of concerns about the quality, safety, and privacy of mobile mammography service, positive experiences changed their attitudes towards these services. These findings highlight the need to include community education when using mobile mammography service to increase screening mammography rates in underserved communities.

CLINICAL RELEVANCE/APPLICATION

Mobile mammography services providing screening mammography to underserved communities should study and address concerns and cultural issues related to delivery of these services as part of their program.

SSM01-05 Self-Compression in Mammography: A Randomized, Non-Inferiority Phase 3 Trial

Wednesday, Nov. 29 3:40PM - 3:50PM Room: E451A

Participants
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Philippe Troufleau, MD, Vandoeuvre-Les-Nancy, France (*Abstract Co-Author*) Nothing to Disclose
Bruno Boyer, MD, Vandoeuvre-les-Nancy, France (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the non-inferiority of the self-compression mammography technique on the breast thickness compared to standard compression.

METHOD AND MATERIALS

549 women aged from 50 to 75 years old from 6 institutions were randomly assigned in a 1:1 ratio to the self-compression or standard compression group after checking their capability to run self-compression. The primary outcome was the breast thickness. The predefined non-inferiority margin was a difference of 3 mm for each view: right/left Craniocaudal (CC) and right/left mediolateral oblique (MLO). Compression force in Newton and image quality blindly quoted with a 4-points scale were also recorded for each view. Overall pain (10 points visual analogue scale) was recorded after CC and MLO views. Additional views (lateromedial LM, spot views, ...) were performed after pain evaluation and their number was recorded. 548 women were included in the intention-to-treat analyses (275 in the self-compression group and 273 in the standard compression group).

RESULTS

The reproducibility of the breast thickness measures was excellent for the four views with an intra-class correlation coefficient of 0.917 (95%CI, 0.902 to 0.929). The right CC breast thickness was 50.78 +/- 15.3 mm in self compression and 51.54 +/- 13 in the standard procedure (difference -0.76; 97.5%CI -8 to -1.24, p = 0.001). Compression force was higher in the self-compression arm versus standard compression arm for the 4 views. No difference was reported in the quality score in the two groups. Pain evaluation was 2.86 +/- 2.32 in the self-compression arm and 3.40 +/- 2.42 in the standard arm (p= 0.009). A median of 2 extra-views per woman was performed in both group (p=0.638).

CONCLUSION

Self-compression mammography technique is not inferior to standard compression technique to achieve the minimal breast thickness. Overall pain is inferior in the self-compression technique without compromising image quality.

CLINICAL RELEVANCE/APPLICATION

Self-compression could be proposed in the mammography practice and decrease the discomfort sometimes associated with mammography.

SSM01-06 Breast Radiology: Reduced Diagnostic Efficacy in a Developing South-East Asian Country

Wednesday, Nov. 29 3:50PM - 4:00PM Room: E451A

Participants
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Maram Alakhras, Sydney, Australia (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Breast cancer is the leading cause of death in women worldwide. Prevalence in South-East (SE) Asia has shown a 30% increase in cases in the last ten years. In one developing SE Asian country up to 80% of cancers are being detected at stage 3 or 4, demonstrating the need for improvements in diagnostic efficacy. This study aims to investigate the ability of radiologists from one developing (n=35) and one developed (n=15) SE Asian country, using Australian radiologists (n=53) as a baseline.

METHOD AND MATERIALS

A data set containing 60 mammographic cases were used; 40 being normal and 20 showing malignancies. These were read by radiologists in their own countries. Demographic data were obtained from each reader. Each radiologist placed location markers on the lesions they identified, and provided confidence ratings between 2 and 5 with a higher value indicating higher confidence that a cancer exists. Data were compared between the three country-based radiologist groupings using the nonparametric two-tailed Kruskall Wallis and Mann Whitney U tests with a statistical significance set at P-value of <0.05.

RESULTS

Significant differences in scores were shown between radiologist groupings, with those from the developing SE Asian country demonstrating lower sensitivity, specificity, location sensitivity, ROC and JAFROC values (P<0.05). Demographic data indicated that radiologists from the developing countries were significantly younger (P<0.0001), read fewer mammographic cases each week (P<0.0001), read for fewer hours (P=0.0004) and had read for fewer number of years than their Australian (P<0.0001) radiologists. Similar differences were also shown between the developing and developed SE Asian Country.

CONCLUSION

Important variations in diagnostic efficacy between countries for breast cancer detection have been shown. Cost-effective and versatile educational solutions must be sought to address causal agents, so that the efficacy of cancer detection is not dependent on where women are located.

CLINICAL RELEVANCE/APPLICATION

The ability to detect cancer should be similar for women wherever they are located. This study examines if this is the case in a developing and developed SE Asian country compared with a developed westernised country.

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103rd Scientific Assembly and Annual Meeting
November 26 to December 1
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SSM02

Breast Imaging (Tomosynthesis Diagnostic Applications)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451B

BR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Emily F. Conant, MD, Philadelphia, PA (*Moderator*) Consultant, Hologic, Inc Consultant, Siemens AG
Margarita L. Zuley, MD, Pittsburgh, PA (*Moderator*) Research Grant, Hologic, Inc;

Sub-Events

SSM02-01 Digital Breast Tomosynthesis Utilization in the Medicare Population

Wednesday, Nov. 29 3:00PM - 3:10PM Room: E451B

Participants
Gilda Boroumand, MD, Hamden, CT (*Presenter*) Nothing to Disclose
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PURPOSE

Digital breast tomosynthesis (DBT) has been shown to improve the diagnostic accuracy of breast cancer screening and diagnosis, and was approved by the FDA for clinical use in 2011. However, there is limited literature on the current use of DBT in clinical practice. This study seeks to determine the volume of screening and diagnostic DBT in the Medicare population.

METHOD AND MATERIALS

We evaluated the national Medicare Part B Physician/Supplier Procedure Summary Master Files from 2015, the first (and only) year in which procedural billing codes for DBT are available. Screening and diagnostic full-field digital mammography (FFDM) and DBT volume counts were determined by tabulating global and professional component claims. Medicare specialty codes were used to categorize the specialty of the interpreting physicians as radiologists or non-radiologists.

RESULTS

In 2015, a total of 5,730,635 screening FFDM exams were performed, of which 1,084,256 (18.9%) included DBT as an add-on procedure. Diagnostic FFDM exams totaled 1,402,966, with 226,682 (16.2%) including DBT. The vast majority (over 96%) of mammograms were billed by radiologists. Among radiologists, DBT studies were used in conjunction with 19.1% of the digital screening studies and 16.4% of the digital diagnostic studies. For non-radiologist physicians, DBT studies were used with 16.7% of digital screening studies and 8.7% of digital diagnostic studies.

CONCLUSION

The utilization of DBT was rather limited in the first year of its introduction as a billable Medicare procedure, occurring in conjunction with less than 20% of digital mammography exams. Radiologists appear to be earlier adopters of this technology compared with non-radiologists, possibly related to the fact that the latter have far less involvement in the field.

CLINICAL RELEVANCE/APPLICATION

2015 is the first and only year for which DBT volume data are available and it will be important to follow the adoption of the technology in subsequent years.

SSM02-02 Can Tomosynthesis Reduce the Benign Biopsy Rate within the Assessment Setting of Women Recalled From Breast Screening?

Wednesday, Nov. 29 3:10PM - 3:20PM Room: E451B

Participants
Nisha Sharma, MBChB, Leeds, United Kingdom (*Presenter*) Nothing to Disclose
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PURPOSE

Digital Breast Tomosynthesis (DBT) within the UK can be used in women recalled for assessment following an abnormal screening mammogram. It is recognised that DBT as a screening tool has improved the cancer detection rate and reduced the false positive rate of women screened. We wanted to assess the impact DBT would have on our assessment clinics regarding biopsy rates and cancers detected. This was an IRB approved prospective study where all women recalled following abnormal screening mammogram were asked to take part in the study. The tomosynthesis study was read within 6 weeks of the assessment clinic which was performed as standard with the DBT images not avaialble for review so was unable to influence the standard assessment.

METHOD AND MATERIALS

The study ran from 01/11/2015 to 29/07/2016. All women recalled following an abnormal screening mammogram were invited to take part in the study. All women had standard assessment performed. The DBT was double read within 6 weeks of attending the assessment clinic. The number of women who had an intervention, which included FNA and core biopsies, was recorded and the outcome of assessment was also recorded

RESULTS

709 women were recruited to the study. 30 women were excluded as they were clinical recalls. 679 women took part in the study. There were a total of 105 breast cancers in this study (36 non invasive and 79 invasive).475/679 women (70%) had a biopsy as part of the standard assessment and 103 cancers were identified in 102 patients (22% PPV).216/694 women (30%) were discharged following further assessment. If DBT had been used in the assessment setting then 199 biopsies would have been performed based on mammographic findings alone and an additional 44 biopsies due to US findings (36%). 103 cancers were identified (42% PPV), 2 cases of non-invasive were only identified by DBT and 2 cases of malignancy missed by DBT.DBT generated 6 additional biopsies, of which 2 were malignant.

CONCLUSION

DBT in the assessment setting is a cost effective imaging tool as it would have reduced the number of benign interventions and improved the positive predictive value of identifying malignancy. 2 cancers were missed on DBT but these were 2 cases of low volume malignancy that may be considered over diagnosis in this current era.

CLINICAL RELEVANCE/APPLICATION

DBT is a vital addition with regards to triple assessment and minimising benign biopsies within the screening assessment setting

SSM02-03 The Radial Scar Dilemma: Incidence and Surgical Upgrade Rates with Tomosynthesis

Wednesday, Nov. 29 3:20PM - 3:30PM Room: E451B

Participants
Reni S. Butler, MD, Madison, CT (*Presenter*) Research Grant, Seno Medical Instruments, Inc.
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PURPOSE

To evaluate the incidence and malignant upgrade rates of surgically excised radial scars before and after the implementation of tomosynthesis.

METHOD AND MATERIALS

Institutional review board approval was obtained for this Health Insurance Portability and Accountability Act-compliant protocol. Medical records of patients diagnosed with radial scar at our institution in the last 8 years were retrospectively reviewed. The incidence of radial scar diagnosed as the primary imaging finding in the 3 years prior to tomosynthesis was compared to that in the 5 years after its implementation. For each lesion, type of mammographic finding; patient age and presentation; lesion size; core needle biopsy imaging guidance, needle gauge, and number of samples; core biopsy histology; and final pathology at surgical excision were reviewed, and upgrade to malignancy at surgical excision was calculated. Statistical significance was evaluated using chi square with Yates' correction.

RESULTS

129 surgically excised radial scars were identified, 27 in the 3 years prior to tomosynthesis and 102 in the 5 years since then. The pre-tomosynthesis incidence of radial scar was 0.5/1000 patients, compared to 1.3/1000 patients after tomosynthesis ($p<0.0001$). Architectural distortion on screening mammography was the most common presentation, representing 58.9% (76/129) of radial scars overall, and 79.4% (81/102) of radial scars after tomosynthesis. 90.7% (117/129) of lesions were evaluated histologically with core needle biopsy prior to surgical excision. Of these, 6.8% (8/117) were upgraded to malignancy on surgical excision. The likelihood of malignant upgrade increased with patient age and lesion size, and decreased with larger volume of tissue sampling. The strongest correlation was seen with presence of atypia on core biopsy pathology. Malignant upgrade for radial scars with atypia was 29.2% (7/24) compared to 1.1% (1/93) for those without atypia on core needle biopsy.

CONCLUSION

The incidence of radial scars has increased significantly since the implementation of tomosynthesis. The low upgrade rate of radial scars without atypia on core needle biopsy suggests that mammographic follow up may be a reasonable alternative to surgical excision for some patients.

CLINICAL RELEVANCE/APPLICATION

with the increased detection of radial scars with tomosynthesis, it may be possible to identify a subset of patients that can be safely followed.

SSM02-04 Architectural Distortion Outcome: Detection only on Tomosynthesis Versus 2D Mammography

Wednesday, Nov. 29 3:30PM - 3:40PM Room: E451B

Participants
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PURPOSE

To compare the outcome of architectural distortion (AD) detected only on digital breast tomosynthesis (DBT) with AD seen at 2D mammography

METHOD AND MATERIALS

This retrospective study was IRB approved and HIPAA compliant. All consecutive cases with architectural distortion assigned BI-RADS 4 or 5 categories from 2009 to 2016 were included. Three readers with 1 to 10 years of experience reviewed all cases for visibility of AD (2D visible vs. DBT detected). Consensus was achieved when 2 readers agreed. Each reader also assigned level of suspicion using a Likert scale (1 to 5) based on mammographic images only. CNB and surgical excision results were compared between 2D- and DBT-detected AD. Frequencies were compared by way of the McNemar test and the Pearson's Chi-square exact test.

RESULTS

181 AD lesions were included; 122 (67.4%) were 2D-detected while 59 (32.6%) were DBT-detected. The malignancy rate at CNB was significantly higher for 2D-detected AD (38.5%) compared to AD detected only on DBT (6.8%) ($p < 0.001$). Likewise, the final malignancy rate after excision of high risk and benign discordant lesions was significantly higher for 2D- detected (43.4%) compared to DBT-detected AD (10.2%) ($p< 0.001$). An US correlate was more likely to be present with AD detected by 2D (n= 103/122, 84.4%) than DBT (n= 33/59, 55.9%) ($p < 0.001$). When no US correlate was present among DBT-detected AD, the malignancy rate was low (7.7%) but not significantly different than when an US correlate was present (12.1%)($p = 0.65$). Regarding the level of suspicion of AD, there was substantial inter-reader agreement (κ Coefficient= 0.61-0.77). When NPV is considered as Likert 1-2, NPV is high (93.8, 81.4, 82.9) but not sufficient to consider follow up over biopsy based on radiologist level of suspicion.

CONCLUSION

DBT-detected AD has significantly lower malignancy outcome compared to 2D-detected AD (10.2% vs. 43.4%), however the malignancy rate is still sufficiently high to warrant biopsy

CLINICAL RELEVANCE/APPLICATION

DBT-detected AD has a lower risk of malignant outcome than AD detected at 2D, but still warrants biopsy even when there is not an US correlate.

SSM02-05 Pure Architectural Distortion on Digital Breast Tomosynthesis: Imaging Characteristics and Histopathologic Outcomes

Wednesday, Nov. 29 3:40PM - 3:50PM Room: E451B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To evaluate imaging characteristics of pure architectural distortion on digital breast tomosynthesis (DBT) and assess their association with histopathologic outcomes.

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board and HIPAA-compliant. DBT exams performed between January 2014 and December 2015 were reviewed for architectural distortion without an associated mass. Imaging characteristics evaluated were size, one versus two-view visualization, and conspicuity compared with 2D mammography. Corresponding ultrasound (US) and MRI exams were assessed for correlates to pure architectural distortion on DBT. Biopsy and surgical pathology were reviewed. A two-tailed t test and Fisher's exact tests were performed.

RESULTS

During this two-year period, 101 cases of pure architectural distortion were visualized on DBT in 97 patients (ages 36 - 83 years,

mean 56 years). Core needle biopsy or surgical excision of 95 cases of pure architectural distortion yielded malignant pathology in 43/95 (45%) tissue samples, of which 39/43 (91%) were invasive and 39/43 (91%) were nuclear grades 1 or 2. The most common benign pathologies were radial scar/complex sclerosing lesion and stromal fibrosis, with each present in 19/52 (36%) benign biopsy specimens. Associations between imaging characteristics of pure architectural distortion on DBT and histopathologic outcome were not statistically significant, including size (2.7+1.3 cm malignant vs 2.4+0.9 cm benign; P=0.12), two-view visualization (39/43 malignant vs 44/52 benign; P=0.54), and increased conspicuity on DBT compared with 2D mammography (32/43 malignant vs 36/52 benign; P=0.65). The presence of an US correlate was associated with malignancy (38/43 malignant vs 27/52 benign; P=0.0001). MRI was performed in 31 cases. The presence of an MRI correlate was associated with malignancy (25/25 malignant vs 3/6 benign; P=0.004).

CONCLUSION

Pure architectural distortion on DBT is malignant in nearly half of cases, demonstrating low or intermediate grade invasive cancers in the majority of such cases. The presence of US and MRI correlates is associated with malignancy.

CLINICAL RELEVANCE/APPLICATION

Detection of pure architectural distortion on DBT has a high positive predictive value for malignancy, particularly in the presence of an ultrasound correlate.

SSM02-06 Synthetic 2D Mammography Can Replace Digital Mammography as an Adjunct to Digital Breast Tomosynthesis: Experience with a Wide-angle Tomosynthesis System

Wednesday, Nov. 29 3:50PM - 4:00PM Room: E451B

Participants
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PURPOSE

To evaluate the lesion detection and diagnostic performance of synthetic 2D mammography (SM) with wide-angle digital breast tomosynthesis (WA-DBT) compared to digital mammography (DM) alone and in combination with WA-DBT.

METHOD AND MATERIALS

Included in this retrospective study were patients who underwent bilateral DM and WA-DBT between March 2015 and June 2015. The standard of reference was histology and/or one-year stability at follow-up. Ultimately, 205 women with 179 lesions were included (89 malignant, 90 benign). Four readers, blinded to results, randomly evaluated images from five different protocols: two view 2v-DM alone; 2v-DM with 2v-WA-DBT; 2v-SM with 2v-WA-DBT; one view (medio-lateral oblique) 1v-DM with 1v-WA-DBT; and 1v-SM with 1v-WA-DBT. Images were evaluated according to the BI-RADS lexicon. Lesion detection, sensitivity, specificity, and accuracy were calculated and compared using multivariate analysis (Generalized Estimating Equations).

RESULTS

Average detection rate was 75.4% for 2v-DM, 80.2% for 2v-DM with WA-DBT, 78.5% for 2v-SM with WA-DBT, 77.4% 1v-DM with WA-DBT, and 75.0% 1v-SM with WA-DBT. Differences in lesion detection were found between reading protocols (P=0.001) and readers (P<0.001). Regardless of inter-reader variations, 2v-DM with 2v-DBT achieved a higher detection compared to 2v-DM (P=0.004). No significant differences in detection were found between 2v-DM with WA-DBT and 2v-SM with WA-DBT (P>0.110). Detection was higher when two views were available, for both SM and DM (P<0.034). Average sensitivity, specificity, and accuracy were: 72.5%, 60.2%, 67.5% for 2v-DM; 82.6%, 64.6%, 75.0% for 2v-DM with WA-DBT; 83.1%, 67.7%, 76.8% for 2v-SM with WA-DBT; 81.7%, 64.0%, 74.7% 1v-DM with WA-DBT; 79.8%, 69.9%, 75.8% 1v-SM with WA-DBT. Sensitivity and accuracy were lower with DM alone compared to the other reading protocols (P<0.001). There were no other significant differences in sensitivity, specificity or accuracy.

CONCLUSION

Compared to 2v-DM alone, 2v-WA-DBT with 2v-DM or 2v-SM improves detection, sensitivity, and accuracy with no significant effect on specificity. 2v-SM with 2v-WA-DBT performed as well as 2v-DM with 2v-WA-DBT. Two-view protocols allow for higher lesion detection.

CLINICAL RELEVANCE/APPLICATION

2v-WA-DBT with 2v-DM and 2v-WA-DBT with 2v-SM allow for a higher detection rate and an improved diagnostic performance than 2v-DM. SM can be safely used to replace DM, in combination with 2v-WA-DBT.

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SSM03

Cardiac (Congenital Cardiovascular Disease)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S502AB

CA CT MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSM03-01 Self-Navigated Free-Breathing Radial Whole-Heart MR Angiography for the Assessment of Coronary Artery Anatomy in Congenital Heart Disease

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S502AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To assess a free-breathing self-navigated three-dimensional (SN3D) radial whole-heart MR angiography (MRA) pulse sequence for the evaluation of coronary artery (CA) anatomy in patients with congenital heart disease (CHD).

METHOD AND MATERIALS

SN3D datasets were previously acquired in 109 patients (20.1±11.8 years) as part of a prospective clinical trial for the assessment of CHD anatomy using a 1.5T scanner. SN3D datasets, retrospectively evaluated by three radiologists, were scored based on the appearance of CA segments and reader confidence in determining CA dominance using a two-point scale. A three-point scale was used to rate overall image quality along with the ability to freeze cardiac and respiratory motion. Vessel sharpness of the internal thoracic artery (ITA, representing respiratory motion), the left anterior descending (LAD) and right CA (RCA, representing a combination of respiratory and cardiac motion) were quantitatively measured using a dedicated prototype application (SoapBubble). Wilcoxon statistics, Pearson correlation, and Intra-Class Correlation (ICC) were used to evaluate the data.

RESULTS

The average duration of the SN3D acquisition was 9.1±2.4 minutes. The mean score for overall image quality was 2.35, with excellent agreement (ICC 0.95). A diagnostic study was obtained in 83.7% of scans with excellent image quality in 51.7% of them. The SN3D technique was able to successfully visualize the individual CAs in the following percentage of cases: left main 92.6% (ICC 0.66), LAD 88.3% (ICC 0.59), RCA 87.8% (ICC 0.55), left circumflex 82.8% (ICC 0.74), posterior descending 50.2% (ICC 0.46), and first diagonal 39.8% (ICC 0.64). Diagnostic confidence for the assessment of CA dominance was scored at 1.56. Image quality was affected more by cardiac motion freezing (mean score, 2.18; Pearson's r=0.73, P<0.029) than respiratory motion freezing (mean score, 2.20; r=0.58, P<0.029). The ITA, RCA, and LAD vessel sharpness scores were 53.1, 52.5, and 48.7%, respectively.

CONCLUSION

In the majority of young CHD patients, SN3D MRA allows for the visualization of the proximal CAs with excellent quality. However,

the quality of cardiac motion freezing still has a strong impact on image quality.

CLINICAL RELEVANCE/APPLICATION

SN3D MRA is a promising technique in CHD patients especially when impaired breath-holding capacity limits the visualization of CA anatomy due to motion artifacts.

SSM03-02 Evaluation of 3D Magnetic Resonance Imaging of Autopsied Human Heart Specimens for Computational Modeling of Congenital Heart Diseases

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S502AB

Participants
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PURPOSE

Autopsied human heart specimens of congenital heart disease are valuable for medical education and surgical simulation in understanding complex anatomical structure. Because of the decreasing number of autopsies and the deterioration of human heart specimens over time, digitalization, such as computational modeling using 3D image data, is an effective approach to capture these valuable specimens. This study aimed to compare the visibility of formalin-fixed heart among various 3D MRI sequences and to clarify the optimal sequence for the computational modeling of congenital heart disease.

METHOD AND MATERIALS

Five human hearts with various types of congenital heart diseases obtained during autopsy and preserved with formalin fixation underwent ex vivo MRI with a 3T clinical machine. The different types of 3D MRI sequences were performed in the same spatial resolution (1.0*1.0*1.0mm): T2-SPACE (3D with a constant flip angle to acquire bright blood imaging), True-FISP (SSFP imaging), MPRAGE (inversion-recovery-based T1WI), and FLASH (basic GRE sequence). The autopsied heart was scanned in a plastic container filled with normal saline. Among the four 3D sequences, we compared the contrast ratio between the myocardium and the ventricular lumen and between the vascular wall and the lumen. In addition, we visually assessed the cardiovascular structure using MPR and 3D images.

RESULTS

The average contrast ratios between the myocardium and the ventricular lumen in MPRAGE, T2SPACE, FLASH, and True FISP were 0.80, 0.31, 0.26, and 0.28, respectively. The average contrast ratios between the vascular wall and the lumen were 0.78, 0.43, 0.32, and 0.20, respectively. MPRAGE showed the best contrast for the imaging of both the myocardium and the vascular structure. By visual assessment, MPRAGE also provided more detailed information on morphology and cardiovascular continuity.

CONCLUSION

MPRAGE is the optimal sequence for the computational modeling of human autopsied heart specimens fixed by formalin, which replaces water in cardiac tissue, with congenital heart diseases.

CLINICAL RELEVANCE/APPLICATION

MPRAGE showed the best contrast for imaging a formalin-fixed heart. The computational cardiac modeling of autopsied heart using MPRAGE plays a critical role in surgical simulation and education.

SSM03-03 Right Ventricle Native T1 Mapping and Pulmonary Regurgitation in Patients with Congenital Heart Diseases: Preliminary Data

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S502AB

Participants
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Marco Ali, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose
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Massimo Lombardi, MD, Trondheim, Norway (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To correlate native T1 mapping (nT1) of the right ventricle (RV) with biventricular functional parameters and pulmonary regurgitation.

METHOD AND MATERIALS

We prospectively evaluated 27 patients (24±10y, mean ± standard deviation) who underwent a cardiac magnetic resonance exam at1.5T. Six patients were treated with percutaneous pulmonary valve. For each patient left (LV) and right ventricle (RV) functional evaluation was performed. Pulmonary flow analysis with phase-contrast sequences was performed and regurgitation fraction (RF) was calculated. A native modified look-locker inversion recovery (MOLLI) prototype sequence was acquired at basal, mid and apical-ventricular level in short-axis view in systole, by starting the data acquisition at the individually adopted trigger time. The MOLLI sequence included motion correction and subsequent automatic generation of T1 maps. Spearman and Mann Whitney U test were used for statistical analysis.

RESULTS

LV functional parameters were: end-diastolic volume (EDVi) 77±20 (mean±standard deviation), LV end-systolic volume (ESVi) 29±16, LV stroke volume (SV) 82±16 and ejection fraction (EF) 63±8. RV functional parameters were: RVEDVi 101±27, RVESVi 47±17, RVSV 96±30 and EF 55±10. Mean RF was 26±18 % and mean nT1 was 1025±38 ms. A negative significant correlation between RVEF and nT1 (r=-333, P=.045) and between RF and nT1 (r=-234, P=.047) was found. nT1 was 1006±95 ms in patients before pulmonary valve treatment and 1087±87 ms in patients after percutaneous implantation (P = .057).

CONCLUSION

Native RV T1 mapping was negatively correlated with PR and RVEF, reflecting an adaptation of RV muscle to the pulmonary conduit dysfunction. A borderline significant increase of nT1 in patients after pulmonary percutaneous treatment was found.

CLINICAL RELEVANCE/APPLICATION

RV T1 value should be used as an early indicator of RV dysfunction in patients with congenital heart diseases.

SSM03-04 Anatomy of Retroesophageal Major Aortopulmonary Collateral Arteries in Pulmonary Atresia with Ventricular Septal Defect: Results from Preoperative CTA

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S502AB

Participants
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PURPOSE

There is little information in the literature available on major aortopulmonary collateral arteries (MAPCAs) anatomy, especially about the retroesophageal MAPCAs (REM). This study aimed to assess the anatomy of REM in pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries (PA-VSDMAPCAs) patients.

METHOD AND MATERIALS

We retrospectively analysed 130 consecutive PA-VSD-MAPCA patients with preoperative CTA who underwent cardiac surgery. A detailed analysis of the MAPCAs anatomy was made using CT imaging, including the total number, origin and stenosis of MAPCAs, the presence or absence of a retroesophageal course for MAPCAs, relationship between MAPCAs and tracheal at the pulmonary hilum. MAPCAs were divided into two groups on the basis of REM diagnosis by CT: REM group (REM diagnosed by CT, n=94) and Not REM group (no REM diagnosed by CT, n=183).

RESULTS

A REM was identified in 82 of the 130 patients (63%), all of which were located on the side opposite the arch. REM group originate higher level of thoracic vertebrae (level 6), compared with Not REM group (level 5) (P<0.01), and REM group have a higher probability to originate from the lateral side of the aorta median degree of 144, contrast to median degree of 90 for Not REM group (P<0.01). There was a difference in the occurrence of stenosis comparing REM group to Not REM group (89% vs 78%), ($\chi 2$=9.79, P< 0.01). A midsegment stenosis was present more often in REM group compared with Not REM group (31% vs 21%), ($\chi 2$=6.27, P= 0.01). Relative to trachea, there was a difference in the anterior-posterior position comparing REM to Not REM group at the pulmonary hilum (91% MAPCAs posterior to tracheal vs 51% MAPCAs posterior to tracheal), ($\chi 2$=50.81, P<0.01).

CONCLUSION

Sixty-three percent of patients with PA-VSD-MAPCAs have a retroesophageal MAPCA, and a left aortic arch was associated with a higher prevalence of the retroesophageal MAPCAs. Compared with not retroesophageal MAPCAs, the retroesophageal MAPCAs associated with higher level, more lateral origin, more stenosis, particularly a midsegment stenosis, and were prone to course posterior to tracheal at the pulmonary hilum.

CLINICAL RELEVANCE/APPLICATION

The anatomy of retroesophageal MAPCAs is highly relevant and useful for surgeons in identifying the retroesophageal MAPCAs to perform unifocalization procedures for PA-VSD-MAPCAs patients

SSM03-05 Common Atrium and the Associated Malformations: Evaluation by Low-Dose Dual-Source Computed Tomography

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S502AB

Participants
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PURPOSE

To determine CA characteristics and diagnostic accuracy in assessing associated malformations in these patients with low-dose DSCT.

METHOD AND MATERIALS

This study was approved by the Institutional Review Board, and informed consent was obtained from all patients. Twenty-one pediatric and adolescent CA patients underwent low-dose DSCT. Different ventricular types and associated malformations were assessed. The diagnostic accuracy of DSCT and transthoracic echocardiography (TTE) in evaluating associated malformations were assessed by reference to surgical results. The effective doses of low-dose DSCT were calculated.

RESULTS

Seven CA patients and 14 CA with single ventricle (SV) were finally included. In the CA with SV, three types of SV morphology were distinguished: single left ventricle (n = 4), single right ventricle (n = 5) and undifferentiated ventricle (n = 5). Seventy-eight associated malformations were observed, among which 22 were seen in CA and 56 in CA with SV. DSCT was superior to TTE for detection of intracardiac anomalies (sensitivity: DSCT, 92.31% vs. TTE, 76.92%), anomalies of great vessels (sensitivity: DSCT, 100.00% vs. TTE, 77.50%), and of collateral vessels (sensitivity: DSCT, 100% vs. TTE, 20.00%). The estimated mean effective dose was 0.95 ± 0.44 mSv (<1 mSv).

CONCLUSION

Low-dose DSCT is an excellent alternative for pediatric and adolescent patients with CA, providing morphological details of CA and associated malformations with high accuracy.

CLINICAL RELEVANCE/APPLICATION

Common atrium (CA) is a rare complex congenital heart disease. Those with associated malformations who do not receive surgical treatment usually have a poor prognosis. Low-dose DSCT is an excellent alternative for pediatric and adolescent patients with CA, providing morphological details of CA and associated malformations with the high accuracy needed to conduct treatment effectively.

SSM03-06 Anomalous Right Coronary Artery from the Left (ARCA-L): Dual-Source Computed Tomography Angiography (DSCT) Findings in Southwest China

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S502AB

Participants
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PURPOSE

We sought to provide the anatomic particularities of anomalous right coronary artery from the opposite (ARCA-L) in Southwest China on a relatively large scale under the postulation that some anatomy features on DSCT could help predict adverse clinical events.

METHOD AND MATERIALS

Over 18000 patients' coronary computed tomography angiography (CCTA) data was screened from Jan 2012 to Aug 2015. The prevalence of ARCA-L was computed and the subtype was decided by the spatial relationship between the right coronary artery with the pulmonic valve. CCTA was used to evaluated the proximal stenosis, observe the high-risk anatomy features including the take-off angle, proximal length as well as the ostium type and analyze the accompany anomalies. Follow-up was done by telephone and the major adverse clinical event (MACE) was recorded. Wilcox test and Chi-square test were used for testing the difference between groups. Cox hazard analysis was performed to identify prognosis predictive factors. P<0.05 was considered significant and Bonferroni correction of P value was used when necessary.

RESULTS

A prevalence of 0.70% (127/18226) was observed in our population and younger people tend to have higher degree of vessel stenosis (the age among the mild vs the middle vs the severe: 64.7 vs 59.6 vs 56.9, p=0.04). RCA origins from below the pulmonary valve was the most common type in our population. The take-off angle and the proximal stenosis length were found to have significant difference between mild (<30%) and severe stenosis (>=60%) group. An average of 15.3 ± 9.2 months' follow-up was conducted on 65 non-CAD patients. Stenosis severity was the most predictive factor among the anatomy features with a RR of 5.23 (95% CI: 2.34 to 8.47, P<0.001).

CONCLUSION

ARCA-L found on CCTA in the Southwest China has a comparable prevalence with other regions with certain variations in high-risk anatomy features. Stenosis severity was the most reliable prognosis predictive factor for patients with conservative therapy.

CLINICAL RELEVANCE/APPLICATION

Our study proved some potentially malignant anatomic features on CCTA for evaluating patients with ARCA-L. Avoiding overloading exercise might be necessary for such patients.

RSNA 2017 Explore. Invent. Transform.
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McCormick Place, Chicago
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SSM04

Cardiac (Acute Chest Pain/Cardiopulmonary Disease)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S504AB

CA CT

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Jacobo Kirsch, MD, Weston, FL (*Moderator*) Nothing to Disclose

Sub-Events

SSM04-01 High-Risk Plaque Features Predict Ischemia in Acute Chest Pain: A Direct Comparison to On-Site Calculation of CT Derived FFR

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S504AB

Participants
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PURPOSE

The discordance between stenosis and ischemia may affect triage efficiency in acute chest pain patients after coronary CT, therefore methods to predict ischemia based on CT data are relevant to this population. CT derived FFR (cFFR) calculated on-site can evaluate the hemodynamic significance of a lesion quickly. High-risk plaque features (HRF) are also predictive of events in acute chest pain patients. We evaluated the correlation between HRF and cFFR in patients with suspected acute coronary syndrome (ACS).

METHOD AND MATERIALS

Patients with suspected ACS from the ACRIN PA 4005 and CT-COMPARE trials who had undergone both CT and either stress testing or catheter angiography were included. cFFR was calculated on-site using experimental software (Siemens cFFR). Degree of stenosis and presence of HRF (positive remodeling (PR), low attenuation plaque, spotty calcification) were assessed by two readers. Ischemia was defined as cFFR<=0.80. Logistic regression analysis was used to evaluate whether HRFs were independently associated with ischemia on a per-vessel level.

RESULTS

Degree of stenosis, HRF and cFFR were assessed in 320 vessels in 148 patients. Average total processing time for cFFR was approximately 40 minutes per patient. By cFFR, ischemia was present in 94 vessels (29%). In multivariate analyses, risk of ischemia was observed for PR (OR=2.64; 95%CI: 1.13-6.17; p=0.025), presence of 1 (OR=3.48; 95%CI: 1.50-8.14; p=0.004) and >1 (OR=4.43; 95%CI: 1.29-15.20; p=0.018) HRFs independent of stenosis. In 148 vessels with 30-90% stenosis, ischemia was present in 78 vessels (53%). In multivariate analyses, 70-90% stenosis (OR=20.22; 95%CI: 5.12-79.79; p<0.001), presence of 1 and >1 HRFs (OR=2.39; 95%CI: 1.05-5.45, p=0.038; OR=4.73, 95% CI:1.09-12.77, p=0.036, respectively) remained predictors of ischemia, while 50-70% stenosis and PR did not.

CONCLUSION

In patients presenting acute chest pain, presence of any HRF, stenosis>50% and PR are associated with cFFR<=0.80, while in vessels with 30-90% stenosis, presence of any HRF and 70-90% stenosis remained. Therefore, assessment of HRF may determine the need for further testing in acute chest pain patients.

CLINICAL RELEVANCE/APPLICATION

CT derived FFR calculated on-site allows rapid evaluation of the significance of a stenosis. Assessment of high-risk plaque may determine the need for further testing in acute chest pain patients.

SSM04-02 Coronary CT Angiography-Derived Fractional Flow Reserve Based on Machine Learning for Risk-Stratification of Non-Culprit Lesions in Patients with Acute Coronary Syndrome

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S504AB

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PURPOSE

This study sought to investigate the prognostic value of coronary CT angiography (CCTA)-derived fractional flow reserve (CT-FFR) in patients with acute coronary syndrome (ACS) and multivessel disease to gauge significance and guide management of non-culprit lesions.

METHOD AND MATERIALS

We analyzed data of 48 patients (55.8±9.6 years, 60% male) who were admitted for symptoms suggestive of ACS and underwent dual-source CCTA followed by invasive coronary angiography (ICA) with culprit lesion intervention. Culprit lesions were retrospectively identified on CCTA utilizing images obtained during ICA. Non-culprit lesions with >=30% luminal stenosis and deferred intervention were evaluated using a machine learning CT-FFR algorithm (Frontier, Siemens) to determine lesion-specific ischemia, defined as CT-FFR <=0.80. Follow-up was performed to record major adverse cardiac events (MACE).

RESULTS

CT-FFR identified lesion-specific ischemia in 23/81 non-culprit lesions. After a median follow-up of 19.5 months, MACE occurred in 14 patients (29%). Univariate Cox regression analysis revealed that CT-FFR <=0.80 (hazard-ratio (HR) 3.77 [95%CI 1.16-12.29], p=0.027), Framingham risk score (FRS) (HR 2.96 [1.01-7.63], p=0.038), and a CAD-RADS™ classification >=3 (HR 3.12 [1.03-10.17], p=0.051) were predictors of MACE. In a risk-adjusted model controlling for FRS and CAD-RADS™ >=3, CT-FFR <=0.80 remained a predictor of MACE (1.56 [1.01-2.83], p=0.048). Receiver operating characteristics analysis including FRS, CAD-RADS™ classification >=3, and CT-FFR <=0.80 (Area under the curve [AUC] 0.78) showed incremental discriminatory power over FRS alone (AUC 0.66, p=0.032).

CONCLUSION

CT-FFR <=0.80 of non-culprit lesions in patients with ACS and multivessel disease adds prognostic value to identify risk for future MACE.

CLINICAL RELEVANCE/APPLICATION

CT-FFR may have utility to risk-stratify the vulnerability of non-culprit lesions for the prediction of future major adverse cardiac events in patients with acute coronary syndrome (ACS) and multivessel disease.

SSM04-03 Fully Automated Volumetry of Peripheral Lung Vasculature based on Pulmonary CT Angiography for Non-Invasive Diagnosis of Pulmonary Hypertension

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S504AB

Participants
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PURPOSE

To evaluate fully automated volumetry of peripheral lung vasculature based on pulmonary CT angiography (CTPA) for non-invasive diagnosis of pulmonary hypertension (PH).

METHOD AND MATERIALS

93 consecutive patients who underwent right heart catheterisation (RHC) and CTPA within two weeks for suspected PH at our institution were retrospectively reviewed. 19 patients with chronic thromboembolic PH were secondarily excluded resulting in the final study population of 74 patients (mean age 66.2 years, 50 female). In-house developed software was used for fully automated segmentation of the pulmonary vasculature and peripheral vascular volume within 10 mm, 15 mm and 20 mm from the lung borders was caculated for each patient. Vascular volumes were compared between patients with PH (mean pulmonary arterial pressure (mPAP) >= 25 mm Hg) and patients without PH using Stundent's T-test. ROC analyses were done, AUC-values of the vascular volume within 10 mm, 15 mm and 20 mm of the lung periphery were compared and diagnostic accuracy for the detection of PH assessed.

RESULTS

42 out of 74 patients had PH (mPAP 37±11 mm Hg, 57%), 32 had nomal mPAP-values (17±4 mm Hg). Peripheral vascular volumes were significantly enlarged in patients with PH: 86±29 vs. 66±23 cmCubed within 20 mm, 59±24 vs. 42±19 cmCubed within 15 mm and 31±17 vs. 19±14 cmCubed within 10 mm of the lung periphery (p-values < 0.002). AUC-values for the detection of PH were 0.73 for 20 mm, 0.74 for 15 mm and 0.75 for 10 mm of the peripheral vascular volume. Highest diagnostic accuracy was achieved at a cut-off value of 19.4 cm for the 10 mm peripheral vascular volume which identified RHC-confirmed PH with 74% sensitivity, 72% specificity, 78% positive and 67% negative predictive value.

CONCLUSION

Fully automated volumetry of peripheral lung vasculature based on CTPA revealed significantly enlarged peripheral vascular volumes in patients with RHC-confirmed PH compared with patients without PH. Vascular volume within 10 mm of the lung periphery demonstrated the best diagnostic performance and identified PH with high diagnostic accuracy.

CLINICAL RELEVANCE/APPLICATION

Fully automated volumetry of peripheral lung vasculature based on CTPA is a promising, non-invasive tool to identify patients who require further workup for suspected PH.

SSM04-04 Quantitative Assessment of Pulmonary Hypertension Severity Using Late Gadolinium Enhancement and T1 Mapping Techniques of 3T Cardiac Magnetic Resonance

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S504AB

Participants
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PURPOSE

To quantitatively assess the severity of pulmonary hypertension (PH) using late gadolinium enhancement (LGE) and T1 mapping techniques.

METHOD AND MATERIALS

We retrospectively analyzed the data of ten control subjects and 21 patients with clinically diagnosed PH caused by chronic thrombotic PH, Takayasu arteritis, idiopathic PH, atrial septal defect, and Ebstein anomaly. CMR examinations were performed with a 3T scanner including LGE, Cine, and T1 mapping sequences. Based on the New York Heart Association (NYHA) functional class and right heart catheterization, the patients were divided into mild and moderate PH patients and severe cases. Myocardial fibrosis volume (FV), percentage of myocardial fibrosis (pFV), and the parameters reflecting right ventricle function were calculated. Native T1, post-contrast T1, and ECV values in the regions of interest (ROI) at the mid-ventricular short-axis section were measured for the anterior and posterior interventricular insertion points (AIP and PIP), septum (S) (Figure 1), lateral wall and blood pool. Student's t-test, Pearson correlation coefficient and the receiver operating characteristic (ROC) were used for data statistics.

RESULTS

Myocardial fibrosis was present in 19/21 (90.48%) PH patients. FV in PH patients was (5.81 ± 4.76) ml, and the median of pFV was 8.33%. Significant differences between the PH patients and control subjects were present for ECV - AIP ($t = -2.878$, $P = 0.011$), ECV - PIP ($t = -3.816$, $P = 0.002$), and ECV - S ($t = -3.749$, $P = 0.002$). ECV - AIP and ECV - PIP were significantly different from the lateral wall ($t = 2.406$ and 3.970, $P = 0.024$ and 0.001). Table 1 illustrates those correlations between the parameters above and values of right heart catheterization in PH patients. Based on ROC curves (Figure 2), it was observed pFV > 7.25% is capable of identifying severe from mild and moderate PH patients.

CONCLUSION

The pFV and ECV values in the IP and septum could be other markers associated with PH cardiomyopathy. With the increase in PAP and PVR, the areas of myocardial fibrosis were inclined to expand, whereas the extent of myocardial fibrosis did not increase significantly.

CLINICAL RELEVANCE/APPLICATION

CMR quantitative assessment of myocardial fibrosis in the IP and septum may provide more information on the myocardial state, right heart function, treatment and prognosis in PH in the future.

SSM04-05 Incidental Solid Pulmonary Nodules in Emergent Coronary CT Angiography for Suspected Acute Coronary Syndrome: Impact of Revised 2017 Fleischner Society Guidelines

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S504AB

Participants
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PURPOSE

A major criticism of coronary computed tomography angiography (CTA) for suspected acute coronary syndrome (ACS) is that it leads to more downstream testing, mostly follow-up chest CT for lung nodules, than alternative diagnostic tests. In 2017 the Fleischner Society released guidelines with the potential to substantially reduce follow-up testing for incidental lung nodules. Our aim was to evaluate the effect of the revised 2017 Fleischner Society Guidelines on recommendations for follow-up chest CT of incidental lung nodules versus 2005 guidelines in Emergency Department (ED) patients undergoing coronary CTA for ACS assessment.

METHOD AND MATERIALS

Our IRB approved retrospective study included 2,066 ED patients with suspected ACS who underwent coronary CTA between 2012 and 2016. All patients with incidental lung nodules were abstracted from the Radiology Information System (RIS). Recommendations for follow-up chest CT for incidental solid pulmonary nodules according to the 2005 and 2017 Fleischner Guidelines were compared. Patients with a history of smoking were classified as "high risk". Data were analyzed with Student's t test.

RESULTS

413 patients (20%) aged >= 35 years had indeterminate solid pulmonary nodules. 301 patients (73%) were considered low risk and most patients (347/413; 84%) had < 6mm nodules. Per 2017 Fleischner Society Guidelines, follow-up CT of solid lung nodules would only be recommended in 66 (3.2%) of all patients compared to 191 patients (9.2%) based on the 2005 guidelines which resulted in a net reduction of 65% (p<0.001).

CONCLUSION

Application of the 2017 Fleischner Society Guidelines resulted in significantly fewer recommended downstream follow-up CT recommendations for solid nodules compared to 2005 guidelines in patients who underwent emergent coronary CTA for suspected ACS.

CLINICAL RELEVANCE/APPLICATION

Incidental lung nodules are common on coronary CTA; adoption of the 2017 Fleischner Society Guidelines will substantially reduce the number of follow-up chest CT recommendations.

SSM04-06 Lung Cancer Detected on Calcium Scoring CT: Factors Affecting Delayed Diagnosis and Predictors for Survival

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S504AB

Participants
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PURPOSE

To investigate the factors affecting delay in diagnosis among patients who had lung cancer which was detected on coronary artery calcium (CAC) scoring CT and to determine prognostic factors which can predict mortality.

METHOD AND MATERIALS

A total of 156 patients (94 men, mean age 68.5±8.95 years) who underwent CAC scoring CT between January 2010 and December 2014 and were subsequently diagnosed as lung cancer, were retrospectively enrolled. Delayed diagnosis was defined as time interval between CAC scoring CT and the diagnosis of lung cancer more than 1 year. For cases with delayed diagnosis, the reason of delay was assessed. Follow-up clinical outcome data regarding clinicopathologic stage of lung cancer at the time of diagnosis and all-cause mortality were obtained. Logistic regression analysis was performed to identify predictors for advanced stage (stage IV), and Cox proportional hazard regression analysis was performed to determine predictors for mortality.

RESULTS

Among 156 lung cancers, 59 lesions (37.8%) had been delayed in diagnosis. The most common reason was missed lesion on CAC scoring CT (49.2%), and the followings were follow-up strategy with imaging than tissue confirmation in subsolid lesion (22.0%), and interpretation error (malignant lesion being considered as inflammatory lesion, 16.9%). In multivariate logistic regression analysis, age (Odds ratio[OR) 1.047, 95% confidence interval[CI] 0.997-1.099) and lesion size (OR 1.023, 95% CI 0.998-1.049) were significant positive predictors for the advanced stage (P<0.2), and subsolid lesion characteristics (OR 0.186, 95% CI 0.0724-0.478) was a negative predictor (P=0.0005). In multivariate Cox proportional hazard regression analysis, age (hazard ratio[HR] 1.062, 95% CI 1.013-1.114) and lesion size (HR 1.023, 95% CI 1.008-1.038) showed increased hazard ratio for mortality (P<0.2), and subsolid lesion characteristics had decreased hazard ratio (HR 0.34, 95% CI 0.15-0.77;P=0.01).

CONCLUSION

On CAC scoring CT, concerns for detection and interpretation errors for lung cancer may prevent delayed diagnosis. Older age and larger lesion size may have poor survival, in contrast, subsolid lesion characteristics may have better survival.

CLINICAL RELEVANCE/APPLICATION

Concerns for detection and interpretation of lung nodule on CAC scoring CT is required to reduce diagnostic delay of lung cancer, especially in patients with older age and larger lesion size.

SSM05

Chest (Thoracic Malignancy/Thymic and Esophageal)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S404AB

CH CT MR OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Carol C. Wu, MD, Houston, TX (*Moderator*) Author, Reed Elsevier

Sub-Events

SSM05-01 Whole-Tumor Histogram Analysis of Apparent Diffusion Coefficient Maps for the Differentiation of Thymic Carcinoma from Lymphoma

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S404AB

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PURPOSE

To assess the performance of whole-tumor histogram analysis of apparent diffusion coefficient (ADC) maps in differentiating thymic carcinoma from lymphoma, and compare with that of commonly used hot-spot region of interest (ROI) based ADC measurement.

METHOD AND MATERIALS

Diffusion weighed imaging (DWI) data of 15 patients with thymic carcinoma and 13 patients with lymphoma were retrospectively collected and processed with mono-exponential model. The measurement of ADCs were performed by using histogram-based and hot-spot ROI based approach. In histogram-based approach, following parameters were generated, including mean ADC (ADCmean), median ADC (ADCmedian), 10 and 90 percentile of ADC (ADC10 and ADC90), kurtosis and skewness. The difference of ADCs between thymic carcinoma and lymphoma was compared using t test. Receiver operating characteristic analyses were conducted to determine and compare the differentiating performance of ADCs.

RESULTS

Lymphoma demonstrated significantly lower ADCmean, ADCmedian, ADC10, ADC90 and hot-spot ROI based (mean) ADCs than thymic carcinoma (all p values < 0.001), while no differences were found on kurtosis (P=0.412) and skewness (P=0.273). ADC10 demonstrated optimal differentiating performance [cut-off value, 0.403×10-3 mm2/s; area under curve (AUC), 0.977; sensitivity, 92.31%; specificity, 93.33%], followed by ADCmean, ADCmedian, ADC90 and hot-spot ROI based ADC. The AUC of the ROC curve of ADC10 was significantly higher than that of hot-spot ROI based ADC (0.977 vs 0.797, P=0.036).

CONCLUSION

Compared with commonly used hot-spot ROI based ADC measurement, histogram analysis of ADC maps holds the promise in improving the differentiating performance between thymic carcinoma and lymphoma.

CLINICAL RELEVANCE/APPLICATION

our preliminary study results indicated that histogram analysis of ADC maps could be a promising approach to improve the differentiating performance between thymic carcinoma and lymphoma.

SSM05-02 Can CT Textural Analysis Predict the World Health Organization (WHO) Classification of Thymic Epithelial Neoplasms?

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S404AB

Participants
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PURPOSE

To evaluate if CT textural analysis (CTTA) can differentiate between low-risk and high-risk thymic epithelial neoplasms (TENs) on routine CT images.

METHOD AND MATERIALS

The preoperative CT scans of 48 patients diagnosed with a TEN over a 10-year period were reviewed with respect to contour, enhancement pattern, degree of enhancement (relative to skeletal muscle), calcification, pleural effusion, pleural seeding, pericardial effusion, and invasion of local structures. CTTA was performed with commercially available software (TexRAD) that applies a filtration-histogram technique for characterizing tumor heterogeneity. TENs were divided into two groups based on the WHO classification (low-risk = types A, AB and B1; high-risk = types B2, B3 and C). Student t-test was used to compare the mean value of each texture parameter between the two groups. Receiver operating characteristics (ROC) analysis was performed and area under the curve (AUC) was calculated for texture parameters that differed significantly. Sensitivity and specificity were calculated using the cut-off value with the highest AUC.

RESULTS

28 low-risk TENs (3 type A, 18 type AB, 7 type B1) and 20 high-risk TENs (11 type B2, 6 type B3, 3 type C) were included. The degree of enhancement differed significantly between the two groups (p=0.021). No significant difference was identified with respect to contour, enhancement pattern, calcification, pleural effusion or seeding, pericardial effusion, or invasion of local structures. Histogram analysis of CT values showed statistically significant differences in average Mean (SSF0, p=0.03) standard deviation (SD)(SSF0,p=0.006), entrophy (SSF0, p=0.04), mean positive pixels (MPP)(SFF6, p=0.008) and kurtosis (SSF3, p=0.02) values between the low-risk group (Mean 67.1 +/- 20.2/SD 21.2 +/- 6.5/entropy 4.3 +/- 0.3/MPP 32.8 +/- 21.1/kurtosis 0.23 + 0.75) and high-risk group (Mean 55.4 +/- 12.6/SD 16.6 +/- 3.6 /entrophy 4.1 +/- 0.2/MPP 21.1 +/- 6.4/kurtosis 1.14 +/- 1.83). Using an MPP threshold of 26.5, the sensitivity and specificity for differentiating low-risk from high-risk lesions was 90% and 54%, respectively (AUC 0.72).

CONCLUSION

CTTA may be able to separate TENs into low- and high-grade WHO histologic subtypes.

CLINICAL RELEVANCE/APPLICATION

The ability to preoperatively predict the WHO subtype of thymic epithelial neoplasms may help determine the need for preoperative adjuvant treatment.

SSM05-03 A Comparison between 3T MR and Endoscopic Ultrasound for Preoperative T Staging of Potentially Resectable Esophageal Cancer with Histopathological Correlation

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S404AB

Participants
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PURPOSE

To compare the value of 3T magnetic resonance imaging (MRI) and endoscopic ultrasonography (EUS) in the preoperative T staging of potentially resectable esophageal cancer.

METHOD AND MATERIALS

Patients with resectable EC diagnosed by clinical and pathological biopsy were prospectively collected. All patients underwent MRI (including T2-TSE-BLADE, DWI and a radial-VIBE sequence prototype) and EUS within one week before surgery. T staging was assigned on MR and EUS by two independent radiologists and one endoscopist in accordance with the 7th edition of AJCC TNM Classification for EC. Two readers separately determined the EC segment and evaluated the MR image quality using a 5-point score. The consistency of image quality score between two MRI readers and the correlation coefficient between image quality and EC segment were calculated using SPSS 20.0. Considering postoperative pathological T staging results as the gold standard, the performance of MRI (T2-TSE-BLADE + DWI + radial-VIBE) and EUS was evaluated based on the calculation of sensitivity, specificity, positive predictive value and negative predictive value.

RESULTS

A total of 70 patients were enrolled in the study, 16 cases were stage T1, 18 cases were stage T2, 30 cases were stage T3, and 6 cases were stage T4a. The evaluation of the image quality by two readers was almost identical (Kappa=0.825, P <0.001). The correlation coefficients between image quality score and EC segment by two readers were (r = -0.665, P <0.01)and (r = -0.619, P <0.01). The sensitivity values obtained by the two MRI readers for T1-T4a staging were 93.75%, 100%, 90%, 100% and 81.25%, 94.44%, 93.33%, 100%, and the specificity values were 100%, 94.23%, 100%, 98.44% and 100%, 90.38%, 97.50%, 100%; using EUS, the sensitivity and specificity values for T1-T4a staging were 81.25%, 83.33%, 53.33%, 50% and 96.3%, 67.31%, 92.50%, 98.44%.

CONCLUSION

MRI was comparable to EUS in the staging of T1 and T2, and showed advantage over EUS for T3 and T4a staging. MRI can accurately assess the depth of invasion of EC, which can be used as a routine examination for preoperative staging of EC and provide the basis for the formulation of a clinical treatment plan.

CLINICAL RELEVANCE/APPLICATION

(dealing with preoperative T staging of esophageal cancer)"MRI was comparable to EUS in the staging of T1 and T2, and showed

advantage over EUS for T3 and T4a staging."

SSM05-04 Accuracy of a Machine Learning Algorithm for Anterior Mediastinal Mass Diagnosis

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S404AB

Awards
Student Travel Stipend Award

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PURPOSE

The purpose of this study is to evaluate the accuracy of a machine learning algorithm as a diagnostic aid for anterior mediastinal masses (AMM), and to compare the accuracy to expert clinical assessment.

METHOD AND MATERIALS

Cases were identified by searching our medical record for patients with an AMM evaluated with CTs, from 2012-2015. 223 cases were found: 103 thymomas, 40 lymphomas, 12 germ cell tumors, 65 benign lesions (cyst, thymic hyperplasia), and 3 fibrosing mediastinitis. The latter group was excluded as there were too few for reliable diagnosis. We divided the remaining 220 cases into 122 training and 98 test cases. One thoracic radiologist reviewed the training cases for the following: size, attenuation in Hounsfield Units, attenuation homogeneity, shape, midline location, intralesional fat, calcification, vascularity, cystic spaces, preservation of fatty septum, supraclavicular, mediastinal, or internal mammary lymphadenopathy (LAD), chest wall invasion, lung invasion, pulmonary metastases, pleural metastases, and pleural effusion. We evaluated the predictive efficacy of each parameter, as well as age and sex, using the Weka machine learning software. Parameters most predictive of diagnosis were then used to generate a ruleset-based classifier using the JRip algorithm. A thoracic radiologist then blindly reviewed the 98 test cases for the presence of each parameter, to be fed into the classifier, and provided a best-guess diagnosis. A related-samples McNemar test was performed to assess differences in accuracy.

RESULTS

Using the machine learning software, the most predictive parameters for the diagnosis of an AMM were: age, sex, size, attenuation, shape, midline location, internal mammary LAD, mediastinal invasion, and pleural effusion. For the training set, the ruleset classifier correctly diagnosed 103/122 cases (84%). For the test set, the radiologist's best-guess diagnosis achieved an accuracy of 72/98 (74%). The ruleset classifier achieved an accuracy of 79/98 (81%). No significant difference in accuracy was seen (p=0.23). A ruleset-based classifier was constructed from the data.

CONCLUSION

A ruleset-based classifier can achieve accuracy comparable to a thoracic radiologist when evaluating the diagnosis of an anterior mediastinal mass.

CLINICAL RELEVANCE/APPLICATION

This algorithm is a potential semi-automated tool for accurate anterior mediastinal mass diagnosis in resource poor areas.

SSM05-05 Combination of DCE-MRI and DWI in Predicting the Treatment Effect of Concurrent Chemoradiotherapy in Esophageal Carcinoma

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S404AB

Participants
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PURPOSE

To study the value of dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) combined with diffusion-weighted imaging (DWI) in evaluating the effect of concurrent chemoradiotherapy (CCRT) in patients with esophageal carcinoma.

METHOD AND MATERIALS

A total of 76 patients with newly diagnosed esophageal carcinoma were enrolled in this study. All the participants were examined with DCE-MRI and DWI at baseline (pre-treatment) and during the third week after the start of CCRT (post-treatment). The volume transfer constant (Krans), rate contrast (Kep), the contrast agent percentage in the extracel¬lular fluid space (Ve), and the apparent diffusion coefficient (ADC) were measured by two radiologists with greater than 10 years' individual experience. The changes in lesion volume on CT were measured at the completion of radiotherapy and was used as an endpoint to evaluate the predictive ability of DCE-MRI and DWI. All the quantitative parameters were analyzed with the paired t-test and a p-value of less than 0.05 indicated statistical significance.

RESULTS

A total of 76 and 56 DCE-MRI and DWI scans were available for analysis at baseline and at the third week, respectively. Pre-treatment Krans, pre-treatment Kep, pre-treatment ADC ($P < 0.05$), and post-treatment Krans ($P < 0.05$) and ΔKrans, ΔADC ($P < 0.05$) were significantly different after CCRT. Based on the binary logistic model, the ROC analysis demonstrated that the combined predictors demonstrated a high diagnostic performance with a threshold of 0.211 and an AUC of 0.939. The sensitivity and specificity were 98.6% and 73.8%, respectively.

CONCLUSION

The combination of DCE-MRI and DWI, as a noninvasive method, allows for the visualization of esophageal carcinoma lesions and can be used as an early biomarker in the prediction of the effect of CCRT three weeks after treatment initiation.

CLINICAL RELEVANCE/APPLICATION

DCE-MR can detect the effects of radio- and chemotherapy at early time points and is recommended as part of a MR study prior to esophageal carcinoma.

SSM05-06 CT Features of Thymic Epithelial Tumors: Correlation with the Clinical Stage Classification Using the Recently Proposed TNM Staging System

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S404AB

Participants
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PURPOSE

To evaluate the CT features of thymic epithelial tumors with recently proposed TNM staging system and to determine the CT features helpful in predicting patient outcome.

METHOD AND MATERIALS

This retrospective study included 116 patients with thymic epithelial tumor surgically treated. Two radiologists interpreted independently the 21 categories of CT findings and finally classified each category into two groups. Correlation of these categories with new TNM staging system and with prognosis were assessed.

RESULTS

The patients were 68 women and 48 men (median age, 59 years; range, 27-82 years). WHO histologic classification included Type A in 10, Type AB in 22, Type B1 in 28, Type B2 in 24, Type B3 in 10, and Carcinoma in 22 patients. The clinical stage using by TNM staging system were stage I in 92, stage II in 3, stage IIIa in 10, stage IIIb in 2, stage IVa in 3, and stage IVb in 6 patients. In the present study, stage II and greater (stage II-IV) tumors were considered an invasive tumor. There was statistically significant relationship between WHO histologic classification and tumor invasiveness (Fisher, $P < .001$). In multivariable analysis, there were statistically significant differences in tumor contour, adjacent chest wall change, pericardial thickness, and vascular invasion between stage I and stage II-IV (all, $P < .05$). Multivariate analysis using a stepwise forward Cox proportional hazards regression model showed that tumors with lobulated and irregular contour, lobulated and irregular contour with mediastinal fat, presence of hemorrhage/cyst/necrosis, and presence of band-like opacity in the lung were significantly associated with disease progression (all, $P < .05$). Patients with three or four of these factors had a significantly shorter cause-specific survival than the other patients ($P < .001$).

CONCLUSION

CT characteristics of thymic epithelial tumors may be helpful in the classification of the new TNM staging system and the prediction of the worse prognosis.

CLINICAL RELEVANCE/APPLICATION

CT features suggestive of invasiveness in thymic epithelial tumor were irregular contour, absence of chest wall's fat layer, presence of pericardial thickness or vascular invasion. Patients with these factors had the worse prognosis.

SSM06

Chest (Vascular)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406B

CH CT VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM06-01 Diagnostic Accuracy of Non-ECG-Gated Chest CT in the Assessment of Cardiac Chamber Enlargement and Hypertrophy Compared to Cardiac MRI

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S406B

Awards
Student Travel Stipend Award

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PURPOSE

To establish gender specific cut-off values for cardiac chamber enlargement and left ventricular hypertrophy (LVH) on non-ECG-gated chest CT using cardiac MRI as the reference standard.

METHOD AND MATERIALS

218 patients who had contrast enhanced non-ECG-gated chest CT (64-320 detector) and cardiac MRI (1.5-3T) performed within 7 days were identified retrospectively (53% male, 52.9±15.8 years, mean interval between CT and MRI 3.4±2.2 days). The presence of cardiac chamber enlargement and left ventricular hypertrophy (LVH) was established by cardiac MRI as the reference standard, according to current guidelines. Multiple measurements were obtained on axial CT images to evaluate left atrial (LA), left ventricular (LV), right atrial (RA) and right ventricular (RV) chamber size, and LV wall thickness, blinded to the reference standard. ROC analysis was performed to determine optimal gender-specific CT measurement cut-off values for the diagnosis of chamber enlargement (LAE, LVE, RAE, and RVE, respectively) and LVH, with specificity (Sp) >=90%. Inter-observer agreement was evaluated with intra-class correlation (ICC) in a random subset (n=40).

RESULTS

LAE was present in 69 (34%), LVE in 47 (23%), RAE in 45 (21%), RVE in 32 (15%) and LVH in 38 (19%). The following CT measurements were the best discriminators. For LAE, LA anterior-posterior (AP) diameter >=50 mm for males (sensitivity (Sn)=47%, Sp=92%, AUC=0.795) and >=44 mm for females (Sn=54%, Sp=92%, AUC=0.839). For LVE, LV transverse diameter >=58 mm for males (Sn=55%, Sp=92%, AUC=0.842) and >=53 mm for females (Sn=29%, Sp=93%, AUC=0.771). For RAE, RA transverse diameter >=67 mm for males (Sn=59%, Sp=91%, AUC=0.825) and >=63 mm for females (Sn=75%, Sp=92%, AUC=0.925). For RVE, RV transverse diameter >=58 mm for males (Sn=56%, Sp=90%, AUC=0.805) and >=57 mm for females (Sn=57%, Sp=91%, AUC=0.850). For LVH, LV maximal wall thickness >=17 mm for males (Sn=55%, Sp=91%, AUC=0.881) and >=15 mm for females (Sn=78%, Sp=92%, AUC=0.910). Inter-observer agreement was excellent (ICC range 0.887-0.973).

CONCLUSION

Cardiac chamber enlargement and LVH can be reliably identified on contrast enhanced non-ECG-gated chest CT with moderate sensitivity and high specificity.

CLINICAL RELEVANCE/APPLICATION

This study provides gender-specific cut-off values for measurements that can easily be obtained on axial non-ECG-gated CT images to identify cardiac chamber enlargement and LVH with high specificity.

SSM06-02 Correlating Computed Tomography Test Bolus Imaging Dynamics with Pulmonary Vascular Resistance in Pulmonary Hypertension

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S406B

Participants

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PURPOSE

Pulmonary vascular resistance (PVR) is an important parameter in the management of pulmonary hypertension and serves as a primary endpoint to assess the treatment efficacy in several newer targeted therapies. Currently, invasive cardiac catheterization is the gold standard to accurately assess the severity of pulmonary hypertension by providing hemodynamic measures such as PVR and mean pulmonary artery pressure (mPAP). Currently there are no established CT parameters to correlate with PVR. We propose an innovative method using test bolus imaging parameters performed for routine CTPA to correlate with PVR.

METHOD AND MATERIALS

This is an IRB approved retrospective study performed in two separate institutions. Patients included are with known pulmonary hypertension who had a CTPA study within one month of right heart catheterization. CTPA were performed on a 64 slice multidetector CT. Bolus dynamics with 15 mL of intravenous nonionic contrast (Omnipaque 350) and repeated axial images with breath hold at the level of the main pulmonary artery. Full width at half maximum (FWHM) of the test bolus is the width of the main pulmonary artery enhancement curve at half its maximum density.

RESULTS

Out of 221 patients who had undergone CTPA study between January 2010 to December 2013 for evaluation of pulmonary hypertension, 52 of them also had a right heart catheterization within one month of CTPA. Of these 52 patients, 37 fulfilled the selection criteria. A correlation of established size parameters and also FWHM was obtained with catheter angiographic data. There was a strong correlation between FWHM and mPAP ($r=0.65$, p value<0.00001), PVR ($r=0.8$, p value<0.00001) and PVR ($r=0.75$, p value<0.00001) (Fig. 3a, 3b and 3c). There was a poor correlation between MPA, RPA, LPA, MPA/Aorta ratio, A/B and RV/LV and mPAP, PVR and PVRI.

CONCLUSION

This innovative study shows routine CT test bolus dynamic information (FWHM) from CTPA is a simple, reliable and easily available noninvasive method that has a very strong correlation with mPAP and PVR/PVRI as compared with conventional CTPA parameters.

CLINICAL RELEVANCE/APPLICATION

Being noninvasive, these CTPA test bolus parameters are potentially helpful for follow up of patients with pulmonary hypertension, mainly to assess treatment response and progression. Among all the parameters we evaluated the FWHM of test bolus correlates strongly with catheter angiographic parameters.

SSM06-03 Correlation between the Degree of Systemic Collateral Supply and the Severity of Chronic Thromboembolic Pulmonary Hypertension: A CT Angiography Study Using Intra-Arterial Injection

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S406B

Awards
Student Travel Stipend Award

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PURPOSE

It is known that systemic collateral supply develops in chronic thromboembolic hypertension (CTEPH). The aim of this study was to assess whether the degree of shunts from systemic artery to the pulmonary vascular system identified by CT angiography using intra-arterial injection was associated with clinical severity in patients with CTEPH.

METHOD AND MATERIALS

A total of 23 patients with inoperable CTEPH were referred to our cardiology department. During diagnostic right and left heart cardiac catheterization, CT angiography using intra-arterial injection from a catheter in the ascending aorta was performed. One-hundred-and-five ml of 1/3 diluted iodine contrast media (35 ml of 350mgI/ml contrast media and 70 ml of saline) was injected at a speed of 9 ml/sec. CT was imaged at scan delay of 9 sec with a 80-kVp tube voltage setting. Two radiologists evaluated CT images by consensus reading. We measured CT values of the pulmonary trunk (HUpt), sub-segmental pulmonary arteries (HUpa) and segmental pulmonary veins (HUpv).HUdiff was calculated as HUpa (or HUpv) - HUpt. The shunt level was zero of HUdiff < 50. For each additional 50 increase of HUdiff, the shunt level was increased by 1. Two shunt scores in each patient were defined separately as the sum of shunt levels in 42 sub-segmental arteries and 18 segmental veins. Mean pulmonary artery pressure (mPAP) and pulmonary vascular resistance (PVR) were measured by right heart catheterization. Correlations between the shunt scores and hemodynamics were evaluated by Pearson's correlation. A p value < 0.05 was considered to reflect statistical significance.

RESULTS

The mean ± standard deviation of mPAP in the 23 patients was 41.4 ± 8.9 mmHg [range, 25-58]. The mean arterial shunt score was 15.3 ± 16.4 [range, 0-60]; the venous shunt score was 11.7 ± 10.2 [range,1-41]. The shunt score of pulmonary vein was significantly correlated with the mean PAP ($r = 0.56$, $p < 0.01$), whereas the shunt score of pulmonary artery was not ($r = 0.13$, $p = 0.56$)

CONCLUSION

Localization of shunts from systemic artery to pulmonary vessels was possible. The degree systemic collateral supply as indicated by the shunt score may attribute to the clinical severity of inoperable CTEPH.

CLINICAL RELEVANCE/APPLICATION

Systemic collateral supply localized by CT angiography was correlated with the severity of inoperable CTEPH and may give information for stratifying balloon pulmonary angioplasty.

SSM06-04 Treatment Effect of Balloon Pulmonary Angioplasty in CTEPH Quantified by Automatic Comparative Imaging in CTPA

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S406B

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PURPOSE

Balloon pulmonary angioplasty (BPA) in patients with inoperable chronic thromboembolic pulmonary hypertension (CTEPH) can have variable outcomes. To gain more insight into this variation, we aimed to visualize and quantify changes in lung perfusion using CT pulmonary angiography (CTPA). We validated these measurements of perfusional changes against hemodynamic changes measured during right-heart catheterization.

METHOD AND MATERIALS

We studied 14 consecutive CTEPH patients (12 female; age: 65±17), who underwent CTPA and right-heart catheterization, before and after BPA. Post-treatment images were registered to pre-treatment CT scans (using the Elastix toolbox) to obtain corresponding locations. Pulmonary vascular trees and their centerlines were detected using a graph-cuts method and distance transform. Areas distal from vessels were defined for measuring perfusional changes in the parenchyma. Subsequently, the density changes within the vascular and parenchymal areas were calculated and corrected for inspiration level differences, and displayed in color-coded overlays. For quantification, the median and inter-quartile range (IQR) of the density changes were calculated in the vascular and parenchymal areas (ΔVD and ΔPD, respectively). The recorded changes in hemodynamic parameters included changes in systolic, diastolic and mean pulmonary artery pressure (ΔsPAP, ΔdPAP and ΔmPAP, respectively) and in vascular resistance (ΔPVR). The Spearman's correlation coefficients between perfusional changes and hemodynamic changes were tested.

RESULTS

PAP and PVR were significantly improved after BPA. Comparative imaging maps showed distinct patterns in perfusional changes between patients. Within vessels, the IQR of ΔVD correlated with ΔsPAP (R=-0.58, p=0.03), ΔdPAP (R=-0.71, p=0.005), ΔmPAP (R=-0.71, p=0.005) and ΔPVR (R=-0.77, p=0.001, see Figure). In the parenchyma, the median of ΔPD correlated with ΔdPAP (R=-0.71, p=0.005) and ΔmPAP (R=-0.68, p =0.008).

CONCLUSION

Comparative imaging in CTEPH patients offers insight into differences in BPA treatment effect. Quantification of these perfusional changes provides non-invasive measures that reflect hemodynamic changes.

CLINICAL RELEVANCE/APPLICATION

CTPA studies before and after balloon pulmonary angioplasty in CTEPH can demonstrate density changes in the vascular and parenchymal areas and is recommended to monitor treatment effects.

SSM06-05 Radiologist Performance in the Detection of Pulmonary Embolism: Features That Favor Correct Interpretation and Risk Factors for Errors

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S406B

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PURPOSE

To assess factors contributing to accurate detection and erroneous interpretation of PE

METHOD AND MATERIALS

Over 13 months, all CTPA studies were retrospectively re-read by a chest radiologist (rad) with 9 yrs experience. Any disagreement

Over 15 months, all CTPA studies were retrospectively re-read by a chest radiologist (rad) with 9 yrs experience. Any disagreement with the initial read was independently assessed by 2 additional chest rads. Studies with uniform disagreement from initial read were labeled false - (FN, miss) or false + (FP overcall). Studies concordant between initial and re-read were true + (TP) or true - (TN). Number (single vs. multiple), most proximal extent (central [C], lobar [L], segmental [S], and subsegmental [SS]), and specific location of PE were recorded. Also assessed were specialty training, experience, time of study, kV used, resident preliminary read, use of iterative recon (IR), signal to noise ratio (SNR), and reports describing study as 'limited'. Parametric and non-parametric statistical testing was performed (significance $p<0.05$)

RESULTS

Of 2555 CTPA cases assessed, there were 230 TP (170 multiple, 60 single PE), 2271 TN, 35 FN (15 multiple and 20 single PE), and 19 FP studies. Overall sensitivity, specificity, PPV, NPV and accuracy of rads was 86.8%, 99.2%, 92.4%, 98.5%, and 97.9%. Sensitivity for detection of multiple PE (92.4%) was significantly higher than single PE (74.1%, $p<0.01$). Sensitivity for C (100%) and L (97.8%) PE was significantly higher than S (85.9%) and SS (74%, $p<0.01$ for both). Sensitivity of thoracic rads (91.7%) was higher than non-thoracic (82.8%) but only reached significance for isolated PE (89.2% vs 61.4%, $P<0.02$). SNR of both TP (13.4) and TN (13.8) studies was significantly higher than FN (11) and FP(11.6). Other factors were not significant. Compared to other S and SS, there were significantly more FNs in the upper lobe posterior and lower lobe lateral S or SS. There were significantly more FP in the inferior lingula. FP studies were more likely to be described as 'limited' in the report.

CONCLUSION

Accuracy for PE detection is high but errors occur, especially in isolated S or SS PE in posterior S or SS of upper and lateral S or SS in lower lobes. Sensitivity was higher in studies with high SNR and if read by thoracic rads

CLINICAL RELEVANCE/APPLICATION

This study demonstrates that although radiologists are accurate in the detection of PE, errors occur most commonly due to location or PE in specific ' blind spots', especially in studies with poor SNR and when interpreted by a non-thoracic radiologist.

SSM06-06 The Power of Axial Scans with 16cm Wide-Detector Scanner: Dose Reduction in Triple-Rule-Out CT Angiography

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S406B

Awards
Trainee Research Prize - Medical Student

Participants
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PURPOSE

To explore the value of using three consecutive axial scans in the triple-rule-out (TRO) examination for chest pain on a 16cm wide-detector CT system.

METHOD AND MATERIALS

Forty patients with acute chest pain underwent TRO scan and were assigned to study group (group A, n=20) and control group (group B, n=20). In both groups, 120kV tube voltage and automatic current modulation to obtain noise index of 21HU and contrast agent iopamidol (370 mg / ml) were used. For Group A, the time-density curves for pulmonary artery and aorta were monitored to calculate the scan delay time. Two-phasic contrast injection was used: 25mgI/kg/s for 12s in 1st phase and at 3.0ml/s injection rate for 20ml in 2nd phase. The pulmonary artery, coronary artery and aorta were scanned in succession in axial mode to cover the thoracic entrance to the top of the diaphragm. For Group B, scan was triggered by the threshold (100HU) for pulmonary artery to include the thoracic portal to the top of the diaphragm; the coronary artery was scanned after 7 seconds delay, followed immediately by scanning aorta in an helical mode. Contrast agent injection protocol: 25mgI/kg/s for 14s. Images were reconstructed with 80%ASIR-V. CT number and standard deviation (SD) of the thoracic aorta, pulmonary artery, coronary artery, fat and erector spinae muscle were measured to calculate SNR and CNR. Image quality was also assessed using a 5-point system (5: best, 1: worst). Measurements were statistically compared.

RESULTS

There was no difference in age, heart rate and body mass index between the two groups ($P> 0.05$); The CT number, SNR, CNR and subjective score of the two groups were statistically the same ($p>0.05$). However, There was a significant difference in total effective radiation dose between group A (3.3±1.2 mSv) and group B (5.56±0.67mSv) ($P<0.05$), resulting in40.3% effective dose reduction using the 3 consecutive axial scan mode.

CONCLUSION

Using 3 consecutive axial scans in in triple-rule-out (TRO) CTA on a 16cm wide-detector CT reduces both radiation dose and exposure times while maintaining image quality compared with the conventional TRO scanning protocol.

CLINICAL RELEVANCE/APPLICATION

Axial scans may be used on a 16cm wide-detector CT in triple-rule-out CTA to reduce radiation dose and maintain image quality.

SSM07

Emergency Radiology (Musculoskeletal and Spine)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S403B

CT ER MK NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Mariano Scaglione, MD, Castel Volturno, Italy (*Moderator*) Nothing to Disclose
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Sub-Events

SSM07-01 Dual Energy CT for Opportunistic Bone Mineral Density Screening: Identifying Patients at Risk for Fragility Fractures

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S403B

Participants
Tony W. Trinh, MD, Boston, MA (*Presenter*) Nothing to Disclose
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Andrew Primak, PhD, Malvern, PA (*Abstract Co-Author*) Employee, Siemens AG
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PURPOSE

To test the hypothesis that Dual Energy CT derived surrogates for bone mineral density can differentiate between elderly patients with a demonstrated fragility fracture and control patients without fractures.

METHOD AND MATERIALS

12,595 consecutive abdominal/pelvic dual energy CT (DECT) scans (Siemens FLASH scanner, Syngo Via software version VB10) from 4/2013 to 6/2016 were retrospectively reviewed. 585 met inclusion criteria for non-contrast scan in a female aged >=65 with exclusion criteria of osseous metastases, spinal hardware, or motion. The cohort included 101 patients with fragility fractures defined as spinal compression, femoral neck, or pelvic insufficiency fractures visible on the study CT scan. The control group included 97 patients without fragility fractures. Recorded metrics included L1 (or the nearest adjacent non-fractured) vertebral body HU values, calcium concentration (converted from iodine to calcium concentration using a scaling factor derived from calcium phantom calibration scans), and calcium HU values (determined from a virtual non-calcium subtraction algorithm).

RESULTS

Mean average vertebral body ROI values for the fracture and control groups, respectively, were: 86 and 132 HU, 60 and 88 mg/ml Ca, and 119 and 162 calcium HU (t-test $p<0.00001$ for all). ROC analysis showed areas under the curve of 0.75, 0.72 and 0.72 for HU values, Ca concentration, and Ca HU values, respectively. Selecting a high sensitivity value of 90% for use as a meaningful screening test yields threshold values of 138 HU, 172 mg/ml Ca, and 94 Ca HU, with resultant specificities of 42%, 36%, and 38% for HU values, Ca concentration, and Ca HU values, respectively.

CONCLUSION

Patients with fragility fractures have significantly decreased vertebral body HU values, as well as DECT derived Ca concentration and Ca HU values. Ability of these measures to predict patients at risk for fragility fractures is comparable at high sensitivity values considered acceptable for screening. Further work is needed to optimize DECT techniques in order to determine optimal cutoff values, and to potentially improve performance compared to traditional HU values.

CLINICAL RELEVANCE/APPLICATION

Dual Energy CT derived surrogates for bone mineral density may allow for opportunistic bone mineral density screening in patients undergoing abdominal and pelvic CT for other reasons.

SSM07-02 A Focused MRI Protocol for Efficient Detection of Pathology Associated with Thoracolumbar Spine Fractures

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S403B

Participants
Syed M. Karim, MD, Boston, MA (*Presenter*) Nothing to Disclose
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Aaron D. Sodickson, MD, PhD, Boston, MA (*Abstract Co-Author*) Institutional Research Agreement, Siemens AG; Consultant, Bayer

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METHOD AND MATERIALS

Retrospective study of adult patients from 2 affiliated Level I trauma centers. Eligible patients presented to the emergency department between 2008 & 2015 with >= 1 fracture of the thoracic or lumbar spine on CT and MRI of the entire thoracic & lumbar spine within 10 days of CT. Exclusion criteria: > 4 levels fractured, pathologic fractures, isolated transverse/spinous process fractures, osteoporotic fractures, prior vertebral augmentation, prior TL spine instrumentation. Patients with neurologic deficits were not excluded. MRIs were reviewed independently by an orthopaedic spine surgeon and an emergency radiologist. MRIs were reviewed for posterior ligamentous complex (PLC) integrity, marrow edema, epidural hematoma, and cord contusion. Pathology identified outside of 3 levels above & below the fractured level(s) ('focused zone') were reviewed by the spine surgeon to determine if treatment would be altered.

RESULTS

126 patients with 216 fractures on CT identified. Demographics: 81 males (64%); median age 49; 62 (49%) TL junction injuries; 47 (37%) managed operatively. PLC injury identified by at least one reader in 41 (33%) patients with percent agreement for PLC injury between two readers of 96%; κ =0.91. Both readers independently agreed there was no pathology on the complete MRIs outside the focused zone in 101 (80%) patients. None of the outside pathology altered patient management. Percent agreement for the absence of outside pathology was 87%; κ =0.47.

CONCLUSION

A focused MRI protocol of 3 levels above & below a known thoracolumbar spine fracture(s) may miss radiographic pathology, but this pathology does not alter patient care.

SSM07-03 Radiological Predictors for Medial Collateral Ligament (MCL) Injury of the Elbow in the Emergency Department (ED)

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S403B

Awards
Trainee Research Prize - Medical Student

Participants
Jordan Lebovic, BA, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

The Medial Collateral Ligament (MCL) is a primary stabilizer of the elbow and is well visualized on MRI. Specific radiological findings indicating MCL injury on radiographs and CT are under recognized by radiologists. Unrecognized MCL injury can cause post-operative instability and recurrent dislocations. The purpose of this study is to determine whether radiological findings can predict MCL injury in patients with elbow fracture-dislocations.

METHOD AND MATERIALS

Operative reports of 287 patients with elbow fracture-dislocations were reviewed to identify patients with injured and intact MCL. Radiology reports were also reviewed for MCL injury. Both Xrays and CTs were analyzed specifically for MCL injury by radiologist and elbow surgeon.

RESULTS

Only 4.5% (13/287) of the radiology reports for patients with elbow-fracture dislocations mentioned the status of the MCL attachment sites. 46 MCL injuries were evaluated and 19 were found to have either a fracture of the medial epicondyle or the sublime tubercle (5 sublime tubercle fractures and 14 medial epicondyle fractures). 16 intact MCLs were confirmed by operative visualization. 0 of the 16 intact MCLs had either a medial epicondyle fracture or a sublime tubercle fracture. 43% of patients with known MCL injury were found to have fracture (s) at the MCL attachment sites. Using fractures of either the medial epicondyle or sublime tubercle as predictor of MCL status had a sensitivity of 63% (CI 51%-74%), a specificity of 100% (CI 79%-100%) and a negative predictive value of .37 (CI .27-.50).

CONCLUSION

While MRI remains the optimal modality to assess for MCL injury, it is rarely used in ED for elbow fracture-dislocations. Presence of fractures involving medial epicondyle and sublime tubercle on radiographs and CT are critical and must be reported by radiologists to help guide the management.

CLINICAL RELEVANCE/APPLICATION

Using radioglogical predictors for MCL injury could identify patients requiring MCL repair, and thereby prevent post-operative instability and recurrent dislocations.

SSM07-04 Imaging of Necrotizing Fasciitis of the Upper Extremity: Distinguishing Cellulitis from Necrotizing Fasciitis

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S403B

Participants
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Ajay K. Singh, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Cellulitis is a relatively common infection of the skin and subcutaneous tissues which may comprise up to 14% of emergency visits.Necrotizing fasciitis (NF) is a potentially fatal, uncommon infection of the soft tissues which can be difficult to diagnose and distinguish from cellulitis.We aim to analyze and compare imaging findings of cellulitis and NF of upper extremity in our large academic medical center.

METHOD AND MATERIALS

This is a HIPAA compliant, IRB approved, retrospective study of cases imaged between 2003 and 2017. Imaging database of our institution was searched for all cases of upper extremity cellulitis and NF. The reference standard for diagnosis was surgery, and/or clinical follow-up. Medical records were reviewed for patient clinical and imaging variables.

RESULTS

A total of 50 cases were included (mean age:44.5, 25 male 25 female). 15 cases had proven NF by surgery and 35 cases had cellulitis proven surgically and/or clinical follow-up. CT was acquired in 60.0% of NF cases (9/15) and 74.3% of cellulitis cases (26/35). Other imaging modalities used were MRI, plain radiograph, and US. Air was significantly more common present in NF compared with cellulitis (53.3%,8/15 and 20.0%,7/35 respectively) (p=0.04). Other common associated imaging findings with NF were subfascial fluid (n=6) and fascial thickening (n=8). NF was significantly more likely to be fatal compared with cellulitis (20.0%,3/15 and 0%,0/35 respectively) (p=0.02). All cases of cellulitis with soft tissue air, had history of recent incision and drainage, penetrating trauma, IV drug use, injection of steroid or immunization. Skin thickening and superficial subcutaneous tissue involvement was seen in all cases of cellulitis who had CT or MR. Soft tissue abscess was seen more commonly in cellulitis (31.4%,11/35) compared with NF (26.7%,4/15). Cellulitis cases who had soft tissue abscess, had significantly more intramuscular edema (66.7%, 6/9), compared with the cases without abscess (13.6%,3/22)(p=0.007).

CONCLUSION

Soft tissue air, fascial thickening and subfascial fluid collection are significantly more common in the NF than cellulitis.Majority of soft tissue air in cellulitis cases can be explained by history of recent trauma, IV drug use, immunization, incision and drainage, and injection.

CLINICAL RELEVANCE/APPLICATION

Soft tissue air, fascial thickening and subfascial fluid collection are significantly more commonly seen in the NF than cellulitis.

SSM07-05 One-Shot Volume Wrist CT as a Screening Tool: Impact on Detection and Treatment of Fractures

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S403B

Participants
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PURPOSE

Although conventional radiography (CR) is standard, computed tomography (CT) improves fracture detection in patients with wrist fractures. We implemented a fast set-up volume CT protocol in our clinic. Our objective was to evaluate fracture detection and therapeutic impact of this one-shot volume CT protocol in clinical practice.

METHOD AND MATERIALS

Between June 2013 and April 2014, we performed a prospective study on all adult patients with suspicion of acute fractures of the wrist or carpus. After informed consent, all patients first underwent CR, thereafter volume CT of the wrist, and then one year follow-up. Likelihood of fracture presence on a five-point scale was prospectively collected before and after CT. Three surgeons blinded to actual patient treatment independently proposed a treatment regimen (functional, cast, or operation), both based on anonymous clinical and radiological data, first with knowledge of CR, and thereafter with knowledge of CT. A radiologist and a surgeon served as reference standard for presence of fractures based on all data. Observer variability was evaluated with Fleiss kappa statistics. We performed receiver operating curve analyses for fracture detection and calculated proportion of wrists with treatment changes based on CT as compared to CR.

RESULTS

Ninety-eight patients participated (37 % male, mean age 53, range 18-87 years old), with 100 wrist CTs (mean DLP: 36 mGycm). CT detected true-positive fractures in 61 (41 radial, 14 ulnar, 26 carpal fractures), and CR in 45 patients (39 radial, 13 ulnar, 6 carpal fractures). AUC for fracture detection was 0.85 (95% CI:0.77-0.93) for CR and 0.97 (95% CI: 0.93-1.00) for CT. Agreement

on treatment was moderate after CR (Fleiss kappa 0.61 (95% CI 0.51-0.70)) and good after CT (0.75 (95% 0.66-0.84). Treatment changed in 24 (24%, 95% CI 16-33%) - 31 (31%, 95% CI 23-41%) wrists, mostly including refraining from cast immobilization (14-16 patients).

CONCLUSION

Volume CT increases accuracy of fracture detection, mainly of carpal injuries. This has a significant impact on cast immobilization changes in this patient population.

CLINICAL RELEVANCE/APPLICATION

Implementation of low threshold, fast-set up volume CT in patients with suspicion of wrist fractures improves carpal fracture detection and has a high potential to avoid unnecessary cast treatment.

SSM07-06 Emergency Department Overcrowding Delays Time to Radiography and Adversely Affects Outcomes for Hip Fracture Patients

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S403B

Awards
Student Travel Stipend Award

Participants
Brendan Kelly, BMBCh, Dublin, Ireland (*Presenter*) Nothing to Disclose
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PURPOSE

The purpose of this study was to identify if ED overcrowding caused a delayed TTR in our institution and if so what effect it has on patient outcome.

METHOD AND MATERIALS

Patients were identified using the hip fracture database at a tertiary referral urban hospital with an annual ED census of over 53,000 patients. 154 consecutive cases were analysed. ED electronic records (Maxims™) and Radiology (PACS) records were then used to assess the Time to Radiography (TTR). Results were analysed using logistic regression in SPSS™.

RESULTS

154 patients were included (115 female). Mean age was 81.04 (SD; range) (10.28; 44-102). Mean TTR was 110 minutes (73.1; 4-431). The mean total number of patients in the ED at presentation was 59.8 (16.67; range 27-99). Using ANOVA increasing numbers of patients was significantly associated with increasing time to radiography ($p=0.003$). Furthermore the TTR was significantly less (61 minutes vs. 113 minutes) when the ED was not above capacity of 33 patients ($p<0.001$). A regression model built to predict radiography in less than 60 minutes showed that only the total number of patients in the ED was independently associated with TTR ($p=0.03$). Analysing the hip fracture database for outcomes, delay to imaging was not associated with a delay in time to surgery ($p=0.174$), but was significantly associated with Time To Ward (TTW) ($p=0.03$) and length of stay ($p=0.024$).

CONCLUSION

TTR and overall outcomes for patients with a hip fracture are negatively impacted by the number of patients in the ED when they arrive.

CLINICAL RELEVANCE/APPLICATION

The authors hope these data will highlight the need for adequate resourcing of the ED and the healthcare system to deal with overcrowding and, in doing so, help avoid poorer outcomes for patients with time-dependent pathology.

SSM08

Gastrointestinal (CT Technique)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353A

CT GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Naveen Kulkarni, MD, Milwaukee, WI (*Moderator*) Nothing to Disclose

Sub-Events

SSM08-01 Impact of Iterative Reconstruction Algorithms on CT Texture Features of the Liver Parenchyma

Wednesday, Nov. 29 3:00PM - 3:10PM Room: E353A

Participants
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Sanghyup Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate whether CT reconstruction algorithms affect CT texture features of the liver parenchyma.

METHOD AND MATERIALS

This retrospective study included 72 patients (normal liver, n=36; chronic liver disease (CLD), n=36) who underwent 4-phase liver CT scan on a Brilliance iCT scanner (Philips Healthcare). All CT images were reconstructed with filtered back projection (FBP), hybrid iterative reconstruction (iDose4TM), and iterative model-based reconstruction (IMR, L1). On the arterial phase (AP) and portal venous phase (PVP) CT imaging, quantitative texture analysis of the liver parenchyma with single-slice ROI measurement was performed at the level of hepatic hilum using a filtration-histogram statistic-based method (TexRAD) with different filter values (fine, medium, coarse). Texture features including mean attenuation (M), standard deviation (SD), entropy (E), mean of positive pixels (MPP), skewness (S), and kurtosis (K) were compared among three reconstruction methods and between normal liver and CLD.

RESULTS

Iterative reconstruction techniques affected various CT texture features of the liver parenchyma in the same individuals, across the different filters. Among the CT texture features, SD and E were significantly different regardless of filter values, both on the AP and PVP imaging between iDose/IMR vs. FBP, and iDose vs. IMR($P<.05$). When comparing patients with CLD with patients with normal liver, E from the AP images of fine filter was significantly different regardless of reconstruction algorithms($P<.05$).

CONCLUSION

CT texture features of the liver parenchyma on a filtration-histogram method were significantly affected by CT reconstruction algorithms.

CLINICAL RELEVANCE/APPLICATION

Texture analysis using a uniform reconstruction algorithm would be important for a more reliable inter-subject comparison as well as intra-subject longitudinal monitoring.

SSM08-02 Diagnostic Accuracy of Anatomic CT Angiography-based Virtual Hepatic Venous Pressure Gradient in Patients with Portal Hypertension

Wednesday, Nov. 29 3:10PM - 3:20PM Room: E353A

Participants
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PURPOSE

To access the performance of virtual hepatic venous pressure gradient (vHVPG) in diagnosing clinically significant portal hypertension (CSPH) and predicting risk of variceal hemorrhage (VH).

METHOD AND MATERIALS

102 patients were prospectively recruited in 3 high-volume liver centers in China between August 2016 and March 2017 [NCT02842697]. All participants were scheduled to undergo clinically-indicated hepatic venous pressure gradient (HVPG) measurement, CT angiography (CTA), and Doppler ultrasound. vHVPG values were calculated from the reconstructed three-dimensional model of hepatic vein-portal vein system and computational fluid dynamics analysis. The performance of vHVPG in diagnosing CSPH (HVPG >= 10 mmHg) and predicting risk of VH (HVPG >= 12 mmHg) were assessed and compared with that of the imaging-based models (HVPGCT score, Portal diameter) and serum-based models (aspartate aminotransferase [AST] to alanine aminotransferase ratio [AAR], AST to platelet count ratio index [APRI], fibrosis index based on 4 factors [FIB-4]).

RESULTS

As expected, vHVPG was successfully interpreted in patients both with and without CSPH [Figure 1A, 1B]. For diagnosing CSPH, area under receiver operating characteristics curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of vHVPG were 0.875 (0.796-0.953), 0.759 (0.639-0.928), 0.895 (0.737-0.100), 0.969 (0.925-0.100), and 0.459 (0.365-0.581), respectively. Also, for predicting risk of VH, AUC, sensitivity, specificity, PPV, and NPV were 0.865 (0.777-0.953), 0.822 (0.726-0.904), 0.828 (0.690-0.966), 0.923 (0.861-0.983), and 0.649 (0.538-0.781), respectively. Overall, vHVPG showed a better diagnostic performance than that of imaging-based models (HVPGCT score, Portal diameter) and serum-based models (AAR, APRI, FIB-4) [Figure 1C, 1D].

CONCLUSION

The proposed vHVPG provides a novel approach for predicting degree of portal hypertension noninvasively and might facilitate patient counseling, decision-making regarding individualized diagnosis and monitoring. Moreover, it is promising to serve as a surrogate measurement of HVPG when invasive procedure is not available.

CLINICAL RELEVANCE/APPLICATION

(Dealing with portal hypertension) The vHVPG could be used in non-invasive diagnosis of clinically significant portal hypertension and predicting risk of complications like variceal hemorrhage in patients with portal hypertension.

SSM08-03 Dual-Energy CT in Patients with Small HCC: Utility of Noise Reduced Monoenergetic Images on Detection of Wash Out and Image Quality in Delayed Phase

Wednesday, Nov. 29 3:20PM - 3:30PM Room: E353A

Participants
Megumi Matsuda, MD, Toon, Japan (*Presenter*) Nothing to Disclose
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Teruhito Mochizuki, MD, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose

METHOD AND MATERIALS

From April 2016 to March 2017, 20 patients with 33 small HCCs who underwent liver dynamic CT using dual-source dual-energy CT were enrolled. Delayed phase images were generated by 120-kVp-equivalent linear-blended and monoenergetic reconstructions at 40, 55 and 70 keV by standard monoenergetic reconstruction algorithm (sMERA: 40, 55, 70) and nMERA: 40+, 55+, 70+. As the objective analysis of image quality, liver-to-lesion contrast (CR), signal-to-noise ratio of the liver parenchyma and tumor (SNR liver, and SNR tumor), and contrast-to-noise ratio of the tumor (CNR) were calculated and compared. We selected 40+, 55+ and M120 images based on the results of earlier objective analysis, and two independent readers scored conspicuity of wash out in small HCC (tumor conspicuity) on 4-point scales and image quality on 5-point scales as the subjective analysis.

RESULTS

There was no significant difference between CR in nMERA and that in sMERA. At 40keV and 55keV, SNR liver, SNR tumor and CNR in the nMERA were significantly higher than those in the sMERA. The CR, SNR liver, SNR tumor, and CNR at 40+ image were significantly higher than those at other images except for 55+ image. There was no significant difference in these evaluation items between at 40+ image and at 55+ image. According to two observers, the scores of tumor conspicuity and image quality were greatest at 55+ image. The agreements of tumor conspicuity and image quality at 40+, 55+, and M120 images were good or

excellent between the two observers.

CONCLUSION

The 40+ and 55+ images can improve image quality and conspicuity of wash out in small HCC in the delayed phase, especially 55+ image may be most appropriate to detect the wash out of small HCC in delayed phase from the results of both objective and subjective analysis.

CLINICAL RELEVANCE/APPLICATION

The virtual monoenergetic images reconstructed with nMERA, especially 55+ image is useful to detect wash out of HCC in delayed phase.

SSM08-04 Assessment of Patient Size Cutoffs for Acceptable 80 kV And Mixed-kV Image Quality at Abdominal Volume-Mode 2-Rotation kV-mA Switching Dual Energy CT

Wednesday, Nov. 29 3:30PM - 3:40PM Room: E353A

Participants
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Dinesh Gooneratne, MBChB,FRANZCR, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose
Maria Twomey, MBChB, FFR(RCSI), Toronto, ON (*Abstract Co-Author*) Nothing to Disclose
Ravi Menezes, PhD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose
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Patrik Rogalla, MD, Toronto, ON (*Abstract Co-Author*) Institutional Research Grant, Toshiba Medical Systems Corporation

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PURPOSE

Volume-mode 2-rotation kV-mA Switching (V2S) Dual Energy CT (DECT) is a unique DECT technical solution available in 320-row scanners that utilizes 80 kV data. Our purpose was to determine patient size limits that result in unacceptable 80 kV and mixed-kV image quality with this technology (not yet investigated), so that the benefits of V2S DECT can be appropriately utilized.

METHOD AND MATERIALS

We retrospectively reviewed 4-phase V2S DECT abdominal scans reconstructed with 3mm slice thickness, noting patients' weight, body mass index (BMI), anteroposterior diameter (AP) and lateral width (LW). Three GI radiologists examined images in the middle of the liver, pancreas and kidneys, grading overall image quality (IQ) of 80 kV and mixed-kV datases (1=excellent to 5=severe degradation) and image artifacts/reader confidence (1=no artifacts/high confidence to 5= severe artifacts, nondiagnostic). Quantitative assessment of noise and enhancement-to-noise-ratio (ENR) in each organ and abdominal fat was completed. Patient sizes that resulted in unacceptable IQ rankings (i.e., >=4 by any of the 3 readers) were determined.

RESULTS

Forty patients were included. Mean IQ scores were not significantly different for different organs ($p > 0.054$). Difference of mean weight, LW and AP+LW between patients with acceptable and unacceptable IQ was statistically significant (p values of 0.227, 0.0018 and 0.0008), in contradistinction to the difference between BMIs (p=0.0749). There was no statistically significant difference between noise/ENR levels of patients with acceptable and unacceptable quality. Median patient sizes (weight, BMI, LW and AP+LW) that resulted in unacceptable image quality and artifacts were 86 kg, 28.1 kg/m2, 38.3 cm and 73.3 cm. Weight, LW and AP+LW cutoffs that resulted in unacceptable image quality were 74.9 kg, 35.9 cm and 65.9 cm. IQ of mixed-kV datasets was acceptable in all patients with unacceptable 80 kV IQ. Readers agreement was moderate (k=0.522).

CONCLUSION

In very large patients image noise and artifacts can render low kV images unacceptable. Knowledge of the cutoffs for each technology allows better patient selection for low kV and DECT.

CLINICAL RELEVANCE/APPLICATION

Knowledge of size cutoffs for acceptable IQ at 80 kV with V2S DECT allows for appropriate implementation of the low kV and DECT imaging performed with the tested technique.

SSM08-05 K-Edge Spectral Photon-Counting CT Using Dual Contrast Protocol for Peritoneal Cavity Imaging

Wednesday, Nov. 29 3:40PM - 3:50PM Room: E353A

Participants
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Arnaud Thivolet, Lyon, France (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To assess the feasibility of using a prototype spectral photon-counting computed tomography (SPCCT) to explore the peritoneal cavity in rats using simultaneously two contrast agents within blood and peritoneal compartments.

METHOD AND MATERIALS

Approval from the animal ethics committee was obtained. SPCCT with multiple energy bins was performed in two sets of two adult rats using gadolinium intraperitoneal (IP) and iodine intravenous (IV) injections (Protocol A), and conversely (Protocol B). After the 10 minutes needed to perform IP injection, helical scans were performed to explore the abdomen and pelvis without and 30 and 60 seconds after injection. Delayed 3 minutes helical scans were then performed only on organs of interest (OOI), e.g. liver (standard parenchyma enhancement reference), kidney and bladder (contrast agents urinary clearance). Two radiologists performed in consensus a qualitative analysis on conventional CT and K-edge images using a peritoneal opacification index (POI) in 13 regions, as defined in the peritoneal cancer index (score=0 to 3 per region depending on the degree of opacification). Regions of interest were manually drawn on material decomposition iodine and gadolinium K-edge images in OOI for measuring the concentrations of contrast agents.

RESULTS

IP diffusion of both contrast agents was excellent with similar POI on conventional and peritoneal k-edge images of 36/39, 36/39 in protocol A, and 34/39, 37/39 in protocol B. K-edge images showed clear visual separation of the contrast agents with a good IV enhancement (POI of IV agents=0/39 in the 4 rats) and IP opacification. Quantitative analysis in OOI showed IV contrast agent enhancement in the liver (e.g 1.6±0.3mg/mL for iodine, 1.3±0.2 mg/mL for gadolinium at 30 seconds), and excretion in the renal pelvis (e.g 27.8±0.2mg/mL for iodine, 7.8±0.5mg/mL for gadolinium at 60 seconds). Progressive IP excretion of the contrast agents within the bladder was present, consistent with blood diffusion and renal excretion.

CONCLUSION

SPCCT can be used to perform a complete peritoneal dual contrast protocol using K-edge imaging which has potential to evaluate detection and tumoral response of peritoneal metastases.

CLINICAL RELEVANCE/APPLICATION

SPCCT with K-edge imaging is feasible using dual contrast agents within peritoneal and blood compartments allowing a good assessment of the peritoneal cavity in rats.

SSM08-06 Material Density Iodine Images in Dual-Energy CT: Detection and Characterization of Hypervascular Liver Lesions Compared to Magnetic Resonance Imaging

Wednesday, Nov. 29 3:50PM - 4:00PM Room: E353A

Participants
Daniela Muenzel, MD, Munich, Germany (*Presenter*) Nothing to Disclose
Anushri Parakh, MBBS, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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Dushyant V. Sahani, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company; Medical Advisory Board, Allena Pharmaceuticals, Inc
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Ernst J. Rummeny, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To determine the diagnostic potential of Material Density (MD) iodine images in dual-energy CT (DECT) for the detection and characterization of hypervascular liver lesions, using MRI as reference standard.

METHOD AND MATERIALS

Fifty-two patients with 236 hypervascular liver lesions (benign, n=31; malignant, n=205; mean diameter, 29.4mm) were included. All of them underwent both contrast-enhanced DECT and contrast-enhanced abdominal MRI within three months. Late arterial phase CT imaging was performed with dual energies of 140 and 80 kVp. Protocol A showed monoenergetic 65 keV images, and protocol B presented MD-iodine images. Three radiologists independently evaluated randomized images, and lesion detection, characterization, and reader confidence were recorded. Liver to lesion contrast ratio (LLR) and contrast-to-noise ratio (CNR) were assessed. Paired t tests were used to compare LLR, CNR, and the number of detected lesions.

RESULTS

All three observers correctly identified more liver lesions using protocol B vs protocol A: 83.13% vs 63.64%, 84.57% vs 68.09%, and 79.37% vs 65.52%. There was no significant difference between the three observers in classification of a lesion as benign or malignant. LLR was significantly increased in protocol B (2.8±2.33) compared to protocol A (0.77±0.55) and MRI (0.61±0.66). CNR was significantly higher in protocol B (0.08±0.04) compared to protocol A (0.01±0.01) and MRI (0.01±0.01). However, higher diagnostic confidence was reported more frequently by the experienced radiologist when using protocol B vs protocol A (84.6% vs 75%).

CONCLUSION

MD iodine images obtained from dual-energy CT increase the conspicuity in the detection of hypervascular liver lesions with comparable diagnostic performance to MRI.

CLINICAL RELEVANCE/APPLICATION

MD iodine images in DECT improve detectability of hypervascular benign and malignant liver lesions. Improved diagnostic confidence with dual-energy CT can potentially help to reduce the number of additional diagnostic procedures.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Dushyant V. Sahani, MD - 2012 Honored EducatorDushyant V. Sahani, MD - 2015 Honored EducatorDushyant V. Sahani, MD - 2016 Honored EducatorDushyant V. Sahani, MD - 2017 Honored Educator

SSM09

Gastrointestinal (Esophagus and Stomach)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353B

CT GI MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose
Bhavin Jankharia, MD, Mumbai, India (*Moderator*) Nothing to Disclose

Sub-Events

SSM09-01 The Application Value of Spectral CT Low Dose Scanning Protocol Preoperatively Optimized for T Stage on Esophageal Cancer

Wednesday, Nov. 29 3:00PM - 3:10PM Room: E353B

Participants
Yue Zhou, Zhengzhou, China (*Presenter*) Nothing to Disclose
Jianbo Gao, MD, Zhengzhou, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the T stage for esophageal cancer using low dose spectral CT technique, and to discuss the diagnosed accuracy of T stage based on low dose scanning.

METHOD AND MATERIALS

Fifty-two patients with esophageal cancer confirmed by surgery or esophagoscopy randomly divided into two groups were enrolled in our study. Dual-phase chest CT enhancement was performed by using GE HD750 CT. Spectral CT were performed in study group with 350mgI/kg contrast medium injection, while control group underwent conventional 120KVp CT with 450mgI/kg contrast medium injection. Patients were divided into two sub-groups with A/C (FBP reconstruction) and B/D (ASIR). The SNRs, CNRs and subjective image quality score were calculated in four groups. Radiation dose were measured automatically in study group and control group. T stages were evaluated by a radiologist with 10 years experience of CT diagnosis.

RESULTS

The CNR and SNR in four groups showed significant difference ($P<0.05$). The SNR in group B was the highest, followed by group A, group C was the lowest. The overall image quality score and anatomy detailed score among four groups exhibited significant difference ($P<0.05$). Group B was the highest while group C was the lowest. The sensitivity and accuracy in study group (A and B) in terms of T1/2 stage were higher than control group (C and D). With regard to T3, the sensitivity and specificity in study group (A and B) were higher than control group (C and D). The accuracy in diagnosis of T4 between study group and control group were similar.

CONCLUSION

Low dose spectral CT scanning optimized the image quality for chest CT enhancement and reduced the radiation and contrast medium dose. Compared to conventional CT, low dose spectral scanning promoted the differential diagnosis between T1/2 and T3, and improved the sensitivity and specificity in differential diagnosis between T1/2 and T3.

CLINICAL RELEVANCE/APPLICATION

Low dose spectral CT scanning reduced the contrast medium and radiation dose, and improved the sensitivity and specificity in differential diagnosis between T1/2 and T3 for esophageal cancer.

SSM09-03 Fractal Dimension Analysis of Glucose Metabolism in Esophageal Cancer by FDG-PET: Correlation between the Quantitative Evaluation of Tumor Heterogeneity and Malignancy

Wednesday, Nov. 29 3:20PM - 3:30PM Room: E353B

Participants
Toru Tochigi, MD, Chiba, Japan (*Presenter*) Nothing to Disclose
Kiyohiko Shuto, MD, PhD, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Intratumoral heterogeneity is a well-recognized characteristics of cancer. The purpose of this study is to assess the heterogeneity

of the intratumoral glucose metabolism using fractal analysis, and evaluate its prognostic value in patients with esophageal squamous cell carcinoma (ESCC).

METHOD AND MATERIALS

18F-fluorodeoxyglucose positron emission tomography (FDG-PET) was performed in 125 consecutive patients with ESCC. FDG-PET images were analyzed using a fractal analysis software, where differential box-counting method was employed to calculate the fractal dimension (FD) of the tumor lesion. Maximum standardized uptake value (SUVmax) and FD were compared with overall survival (OS).

RESULTS

The median FD was 1.97 (range, 1.7941 -2.0359). The survival curve was analyzed using the median FD as the cutoff value. The survival rate in the high-FD group was significantly better than that in the low-FD group as determined by the Kaplan-Meier method (P = 0.0029). In the multivariate survival analysis, the FD was identified as an independent prognostic factor for the overall survival (<0.0001). Furthermore, we analyzed the overall survival rate in the patients who were treated with surgery alone and with neoadjuvant chemotherapy. The Kaplan-Meier analysis of this data also showed that the high-FD group had a significantly better survival than did the low-FD group (P = 0.0011, P = 0.0177)

CONCLUSION

Metabolic heterogeneity measured by fractal analysis can be a novel imaging biomarker for survival in patients with ESCC.

CLINICAL RELEVANCE/APPLICATION

The preoperative tumor metabolic heterogeneity was a useful biomarker for OS of patients with ESCC, and was independent of clinical markers such as TNM-staging.

SSM09-05 MRI of the Gastric Antrum for the Quantification of Gastric Motility: Comparison between Obese and Normal Weight Patients

Wednesday, Nov. 29 3:40PM - 3:50PM Room: E353B

Participants
Simona Picchia, MD, Rome, Italy (*Presenter*) Nothing to Disclose
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Damiano Caruso, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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Carola Severi, MD,PhD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare differences in gastric motility between obese and normal weight patients with MRI.

METHOD AND MATERIALS

Motility antral scans were obtained by Magnetic Resonance Imaging (MRI) after a liquid meal: patients drunk 650-ml standardized liquid meal over 10 min (Nutridrink) plus two egg yolks and one albumen and 150 ml of water. This 525-kcal meal was composed of 25% fat, 25% protein, and 50% carbohydrate. Imaging was performed on a 1.5-Tesla system. CineMRI for motility analysis was performed using a coronal and axial 2DtrueFISP. Images have been acquired before (T0), immediately after the end of the meal assumption (T1) and every 20 minutes (T2-T5), for a total exam time of 100 minutes. Each gastric motility scan lasted 60 seconds, with 100 images acquired in free breathing. Images have been evaluated on a dedicated software. Two measurements were evaluated. The distal antral contraction waves (ACWs) and the antral diameter. The ACWs were measured as the distance between the proximal and distal border of a segmental contraction of the distal antrum. The antral diameter was measured at the level of the measured ACWs. The measurement lines have been propagated into the next image of the MRI sequence, and the newly detected distance registered. This process has been repeated for every single image of the cine sequence. The temporal changes of the antrum diameter and ACWs over time have been plotted on a graph thus displaying gastric motility frequencies and magnitude. Results obtained in obese and normal weight patints were compared.

RESULTS

Twenty patients were included in the study (10 obese and 10 normal weight). Motility antral scans in obese antrum showed that, during fasting and in the late-postprandial period of a liquid meal, the length of the antrum was significantly shorter with lower maximal contraction amplitude and frequency.

CONCLUSION

MRI is able to identify differences in antral motility between obese and normal weight patients.

CLINICAL RELEVANCE/APPLICATION

This study confirmed the presence of antral motility disfunction in obese patients. These results can be correlated with the previously published in vitro evidence that in antral smooth muscle of obese patients the alteration in VIP pathway occurs, suggesting that smooth muscle might represent a new therapeutical targets in gastrointestinal motility disorders.

SSM09-06 Imaging Assessment of Lauren Classification for Gastric Cancer Using a Non-Gaussian Fractional Order Calculus Diffusion Model

Wednesday, Nov. 29 3:50PM - 4:00PM Room: E353B

Participants
Muge Karaman, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

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Yi Sui, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Kejia Cai, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the performance of a new set of parameters (*D*, *ß*, and *μ*) from a fractional order calculus (FROC) diffusion model for imaging assessment of Lauren classification in gastric cancer.

METHOD AND MATERIALS

With IRB approval, 41 patients (12 females and 29 males) with gastric cancer underwent MRI scans at 1.5T. Surgical specimens were obtained for pathology analysis to determine the cancer type according to Lauren classification, resulting in 10 patients with diffuse type, 23 with intestinal type, and 8 with mix type. For the statistical analysis, the diffuse and mix types were combined as mixed-and-diffuse type (MDT) to be differentiated from the intestinal type (IT). The MRI protocol included T1-weighted (VIBE), T2-weighted (turbo spin echo with respiratory-trigger), and diffusion-weighted imaging with 11 *b*-values (0 to 2000 s/mm2). Three parameters of the FROC model, diffusion coefficient *D*, fractional order parameter *ß* (which correlates with intra-voxel tissue heterogeneity), and a microstructural quantity *μ* were estimated from the diffusion data. The mean values of FROC parameters over the tumor regions of interest were computed. Receiver operating characteristic (ROC) analysis was then performed to assess the performance of FROC model for gastric cancer type differentiation. The combination of FROC parameters (*D*, *ß*, *μ*) were compared to using only *D*, which is equivalent to apparent diffusion coefficient.

RESULTS

A significant difference between MDT and IT were observed in the combination of *D*, *ß*, and *μ* with a p-value < 0.05. The combination of FROC parameters also produced a better accuracy (74.3% vs. 69%), specificity (73.9% vs. 56%), and area under the curve (78.5% vs. 65.2%) than using *D* alone, while providing a comparable sensitivity (75% vs. 78.2%).

CONCLUSION

The combined FROC parameters (*D*, *ß*, *μ*) outperformed *D* in non-invasive imaging assessment of Lauren classification for gastric cancer.

CLINICAL RELEVANCE/APPLICATION

The combined FROC parameters (*D*, *ß*, *μ*) perform better than using diffusion coefficient alone for imaging assessment of Lauren classification in patients with gastric cancer.

SSM10

Genitourinary (Gynecology and Genitourinary Ultrasound)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E351

GU US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Harris L. Cohen, MD, Memphis, TN (*Moderator*) Nothing to Disclose
Mary C. Frates, MD, Sharon, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSM10-01 Impact of Contrast-Enhanced Ultrasound in the Secondary Prevention of Testicular Tumors

Wednesday, Nov. 29 3:00PM - 3:10PM Room: E351

Participants
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Pietro Gisonni, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose
Giuseppina Dell'Aversano Orabona, MD, NAPOLI, Italy (*Presenter*) Nothing to Disclose
Maria Chiara Imperato, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose
Martina Caruso, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose
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Arturo Brunetti, MD, Naples, Italy (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

This study evaluated the role of contrast-enhanced ultrasound CEUS in the secondary prevention of testicular tumours.

METHOD AND MATERIALS

Forty patients (median age 25 years, range 18-36 yrs) with a focal testicular lesion underwent B-mode ultrasound (US), Doppler and CEUS.Then all patients underwent orchiectomy and the histological exam of the mass was performed.Histological features and ultrasound images were recorded and compared for each patient.

RESULTS

The medium diameter of the lesions was 12 mm (range 3- 29 mm). 30 of 50 patients had malignant tumours (75%), 5 had benign tumours (12,5%) and 5 non-neoplastic lesions (12,5%).B-mode US detected neoplastic characteristics only in 9 of the 35 tumoural lesions; with color-Doppler techniques in 10 of 35 tumours was found intralesional hypervascularization (B-mode and color-Doppler US findings suggestive of neoplastic disease were irregular margins and internal hypervascularization).On qualitative CEUS evaluation 34 of the 35 neoplastic lesions showed intense enhancement; on quantitative CEUS all tumours showed different kinetics from the surrounding parenchyma, according to a rapid wash in and wash out for malignant tumours and rapid wash-in but delayed wash-out for benign tumours (CEUS findings suggestive of neoplastic disease were intense enhancement of contrast, rapidity of wash-in and wash-out and peak characteristics).

CONCLUSION

In this study, we confirmed the CEUS high accuracy in the differentiation between malignant and benign small lesions and its utility in the early diagnosis of testicular cancer.Conventional US revealed in all patients the presence of a solid testicular mass and color-Doppler revealed presence of increased blood flow signal, but in small testicular tumours it did not show vascularization and only CEUS was able to do a differential dignosis.Using CEUS, the temporal perfusion dynamics of the contrast enhancement help in the differentiation between malignant and benign tumours; the intensity of contrast enhancement helps in the differentiation between neoplastic and non-neoplastic lesions.Therefore, CEUS is useful in the secondary prevention of small testicular masses with an ambiguous color-Doppler pattern and permits, rapidly and without damage, to predict the lesion nature.

CLINICAL RELEVANCE/APPLICATION

CEUS can add relevant information for surgical decision making in small testicular lesions.

SSM10-02 Utility of Ultrasound Elastography (Acoustic Radiation Force Impulse Imaging) in Differentiating Ovarian Endometriomas from Hemorrhagic Ovarian Cysts; In Correlation with Histopathology

Wednesday, Nov. 29 3:10PM - 3:20PM Room: E351

Participants
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Sudhakar H. K., DMRD, MD, Chennai, India (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To study the usefulness of ARFI in the differentiation of ovarian endometriomas and hemorrhagic ovarian cysts.

METHOD AND MATERIALS

It is a prospective observational study conducted in the department of radiodiagnosis of our institution from january to december 2016. The study population consisted of 35 women(n=40, 5 women with bilateral lesions) of reproductive age group (20-45 y) presenting to the department of radiodiagnosis with unilateral or bilateral adnexal cystic lesions with homogenous internal echoes, diagnosed by grey scale ultrasound.Cystic lesions with mural nodules/solid components/ internal vascularity were excluded from the study. Measurements were performed with SIEMENS ACUSON S 2000 ultrasound system enabled with virtual touch quantification software.Grayscale ultrasound with full bladder was performed on all the patients to clearly define the pelvic anatomy and the lesion position. The lesion was identified and a region of interest (1x0.5cm box within the lesion) within the lesion was selected. The stiffness was measured well within the capsule of the lesion. Five succesful measurements were taken for ARFI shear wave velocity, measured in meters per second and the median value was calculated.Histopathology results, post surgery were obtained for all the 40 lesions and correlated with the SWV values.

RESULTS

Ultrasound elastography (ARFI)was performed on all the 40 lesions and the median shear wave velocities(SWV) were calculated.The definitive diagnosis was made by post operative histopathological examination results and the SWV values were correlated. Out of the 40 cystic lesions, 23 lesions were endometriomas and 17 lesions were hemorrhagic cysts. All the lesions histopathologically proven as endometriomas had higher SWV values compared to those proven as hemorrhagic ovarian cysts.A cut-off value of 2.85m/s was established, concluding the lesions with SWV values above 2.85m/s were more likely to be endometriomas and those below 2.85m/s were more likely to be hemorrhagic cysts with a sensitivity and specificity of 94% and 100% respectively.

CONCLUSION

ARFI imaging is a feasible technique for pre-operative discrimination of ovarian endometriomas and hemorrhagic ovarian cysts.

CLINICAL RELEVANCE/APPLICATION

With the use of this modality clear preoperative diagnosis of the two lesions can be established and the existing diagnostic dilemma leading to unnecessary surgeries can be avoided.

SSM10-03 Quantitative Shear-Wave Elastography of the Testicle: Normal Values and Assessment of the Common Pathological Conditions on a Large Cohort

Wednesday, Nov. 29 3:20PM - 3:30PM Room: E351

Participants
Pierre De Marini, Strasbourg, France (*Presenter*) Nothing to Disclose
Aissam Labani, MD, Strasbourg, France (*Abstract Co-Author*) Nothing to Disclose
Quentin Minault, Strasbourg, France (*Abstract Co-Author*) Nothing to Disclose
Mickael Ohana, MD, PhD, Strasbourg, France (*Abstract Co-Author*) Nothing to Disclose
Herve Lang Sr, MD, Strasbourg, France (*Abstract Co-Author*) Nothing to Disclose
Catherine Roy, MD, Strasbourg, France (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Shear wave elastography (SWE) is the last development in ultrasonic assessment of the tissue elasticity. Our aim was to evaluate the values of the stiffness in normal parenchyma and in common pathologies in order to determine a threshold value for diagnosis.

METHOD AND MATERIALS

This prospective study recorded 235 patients (mean age 43.2±17.2 years, range 17-90) using a Toshiba AplioTM 500 (Toshiba Medical Systems, Japan).Young modulus(YM) values were recorded by mean of a circular ROI over the color map. The cohort was divided into two groups according the grey scale aspect : a normal group of 110 patients with 902 values (67 bilateral, 43 unilateral+125controlateral -3 localizations (superior, mid , inferior) - including microlithiasis and hydrocele) and a pathological group of 125 patients with 375 values (87 lesions up to 5mm, 38 diffuse abnormalities). Final diagnosis was done by clinical findings, follow up or histological analysis. For statistical analysis a Mann-Whitney test was used and the optimal cut off value was calculated from the ROC curves analysis. A P value below 0.05 was considered as significant.

RESULTS

The YM values of free lesion testicle was 4.56±1.53kPa, median = 3.85kPa.There was no significant difference concerning the side, the localization, the presence of hydrocele or stage I or II microlithiasis. There was a significant higher mean value stiffness with age (>60 years: 4.97kPa; p<0.001), stage III microlithiasis (6.27kPa; p<0.001) and in case of contralateral tumor (5.60kPa; p<0.001). The stiffness values and cut off thresholds were for tumors (n= 48, mean = 21.31±7.01kPa, median =19.60kPa , p<0.001) and 16.1kPa(Se= 0.82 - CI95[0.48-0.98], Sp= 0.81 kPaCI95[0.74-0.86], AUC= 0.881), orchitis (n=43, mean = 9.48±3.91kPa, median =6.65kPa, p<0.001) and 5.7kPa (Se= 0.63 - CI95[0.49-0.76], Sp= 0.77 - CI95[0.70-0.83], AUC=0.764) and fibrosis (n=34, mean = 31.55±9.08kPa, median =25.20kPa, p<0.001) and 26.3kPa (Se= 0.82 - CI95[0.63-0.94], Sp= 0.85 -

CI95[0.79-0.90], AUC= 0.872), respectively. By analyzing the distributions between the different pathologies, the difference was statistically significant between orchitis and fibrosis (p= 0.002) and tumors and fibrosis (p<0.001).

CONCLUSION

SWE is a complementary tool to differentiate fibrosis from a tumoral process.

CLINICAL RELEVANCE/APPLICATION

Quantitative SWE is an efficient mean to differentiate a fibrous tissue from a tumoral process on a localized gray scale lesion.

SSM10-04 Clinical Significance of the Slope of the Increasing Pressure Curve When Injecting Ultrasound Contrast Agent during the Evaluation of the Fallopian Tubal Patency

Wednesday, Nov. 29 3:30PM - 3:40PM Room: E351

Participants
Ye Qiang, Nanjing, China (*Presenter*) Nothing to Disclose
Yiyun Wu, Nanjing, China (*Abstract Co-Author*) Nothing to Disclose
Meimei Zhang, Nanjing, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To explore the association between Fallopian tubal patency and the slope of the increasing pressure curve for ultrasound contrast agent.

METHOD AND MATERIALS

A total of 145 patients underwent hysterosalpingo contrast sonography (HyCoSy) between August 2015 and January 2016. HyCoSy was performed with the Voluson E8 ultrasound system (GE Healthcare, Zipf, Austria) equipped with an RIC5-9-D probe. The ultrasound contrast agent was injected and the pressure curve was recorded with a liquid-injecting machine (YLD YZ-800, Yi Lida Corp., Zhu Hai, China) that records the injection pressure in real time and automatically traces it as a pressure curve. We used SonoVue (Bracco International BV, Amsterdam, The Netherlands) as the ultrasound contrast medium. The statistical analysis was performed with SPSS Statistics, version 19 (IBM, Chicago, USA), and $P < 0.05$ was deemed statistically significant.

RESULTS

We divided the patients into three groups according to their different Fallopian tubal patency status: 71 patients (48.97%) in bilateral tubal patency group, 45 (31.03%) in unilateral tubal patency group (one side patent, and the other either passable or occluded), and 20 in bilateral tubal lesion group (both sides passable or occluded). The slopes of the increasing pressure curves for the three groups were 1.242 ± 0.572, 1.472 ± 0.638 and 2.068 ± 1.236 kpa/s, respectively. There was some correlation between the slope of the increasing pressure curve and tubal patency ($R = 0.287$, $P < 0.05$). The slopes differed significantly between the bilateral tubal patency group and the bilateral tubal lesion group ($P < 0.05$) and between the unilateral tubal patency group and the bilateral tubal lesion group ($P < 0.05$). However, the difference between the bilateral tubal patency group and the unilateral tubal patency group was not significant ($P > 0.05$).

CONCLUSION

The slope of the curve tracing the increase in the pressure of the injected contrast agent during HyCoSy is associated with the tubal patency.

CLINICAL RELEVANCE/APPLICATION

Therefore, it can be used as an objective index of tubal patency, and should have utility in both diagnosis and treatment.

SSM10-05 Vasectomy Related Changes in the Scrotum on Ultrasound

Wednesday, Nov. 29 3:40PM - 3:50PM Room: E351

Participants
Pramod K. Gupta, MD, Plano, TX (*Presenter*) Nothing to Disclose
Ann M. Mottershaw, MD, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose
Vidisha V. Ghole, MD, Irving, TX (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

-Vasectomy is a popular method of male contraception, so that a signification proportion of men referred for scrotal sonography will have had a vasectomy. -The purpose of our study is to evaluate the sonographic changes in the scrotum after vasectomy and compare them with the sonographic appearance of non vasectomy patients.

METHOD AND MATERIALS

We performed a comparative study of 75 patients with a history of vasectomy and 75 patients without this history who were referred for scrotal sonography for various indications. Ultrasound findings in these two groups were tabulated and compared.

RESULTS

Certain ultrasonographic findings were more commonly observed in the patients with vasectomy than in non-vasectomy patients. These findings were:Thickened epididymides (41% versus 2%), Tubular ectasia of epididymis(57% versus 4%), both thickened epididymides and epididymal tubular ectasia together (36% versus 2%), sperm granulomas (21% versus 2%), tubular ectasia of rete

testis (29% versus 7%), mediastinal cysts (15% versus 4%), medial rotation of the testis in the scrotal sac which is determined by location of testis-epididymis complex (33% versus 3%). No significant difference was found in the incidence of epididymal cysts, varicoceles and hydroceles in the vasectomy and non vasectomy groups.

CONCLUSION

There was significantly higher incidence of thickened epididymides, epididymal tubular ectasia, sperm granulomas, tubular ectasia of rete testis and mediastinal cysts in the post vasectomy patients as compared to non vasectomy patients. These changes most likely occur due to postvasectomy obstruction, sperm statis and increased intraluminal pressure in the efferent ducts, epididymis and vas deferens. Medial rotation of the testis in the scrotal sac was also more common in the vasectomy group, which is likely due to iatrogenic changes in the structural support mechanism of the testis with resultant increased mobility of the testis within the scrotum.

CLINICAL RELEVANCE/APPLICATION

Familiarity with common ultrasound findings in vasectomy patients may help suggest post vasectomy status when history is not provided and in some cases may help avoid unnecessary intervention.

SSM10-06 Transvaginal Ultrasound (TVUS) Shear Wave Elastography (SWE) for the Evaluation of Benign Uterine Pathologies

Wednesday, Nov. 29 3:50PM - 4:00PM Room: E351

Awards
Student Travel Stipend Award

Participants
Man Zhang, MD,PhD, Ann Arbor, MI (*Presenter*) Nothing to Disclose
Ashish P. Wasnik, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose
William Masch, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Jonathan M. Rubin, MD, PhD, Ann Arbor, MI (*Abstract Co-Author*) Equipment support, General Electric Company; Equipment support, Siemens AG; Equipment support, Koninklijke Philips NV;
Ruth C. Carlos, MD, MS, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose
Katherine E. Maturen, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate myometrial stiffness using TVUS SWE in women with benign myometrial pathologies including adenomyosis and leiomyoma vs. normal myometrium, using pelvic MR as the reference standard.

METHOD AND MATERIALS

Between January 2015 to June 2016, premenopausal women without a history of gynecologic malignancy presenting with pelvic pain and/or bleeding were enrolled in this IRB-approved prospective study. TVUS was performed in SWE mode with multiple regions of interest (ROIs) (>=1 cm2) in the uterus. Multiple shear wave velocities (SWVs) were recorded in each location and averaged. Reference pelvic MR exams were performed with multiplanar T2WI, and T1WI pre and post IV gadolinium administration . MR exams were reviewed in consensus by two radiologists blinded to the US findings, and the presence or absence of adenomyosis and/or leiomyomata was assessed using published criteria. US images were reviewed in consensus by two different radiologists and SWV for each ROI tabulated by anatomic area. Continuous variables were analyzed using means, t-tests and ANOVA, assuming $p < 0.05$ for statistical significance.

RESULTS

34 premenopausal women (mean age 36.8 years, range 22-52) were enrolled with mean time between US and MR 11 days (±27, range 0-118). MR diagnosed adenomyosis in 6 women involving 12 uterine locations, and leiomyomata in 12 women involving 28 uterine locations. Mean SWV in 16 women with normal myometrium was 4.3 m/s (±1.7, range 1.8-9.4), compared with 5.7 m/s (±2.3, range 1.7-9.9) in 18 women with adenomyosis or leiomyomata ($p < 0.0002$, 95% CI of difference -2.2, -0.6).

CONCLUSION

Our pilot study demonstrated that myometrial SWVs were higher in women with adenomyosis or leiomyomata than in women with normal myometrium ($p < 0.0002$), indicating increased tissue stiffness associated with common benign myometrial diseases.

CLINICAL RELEVANCE/APPLICATION

Because women with benign myometrial conditions have increased myometrial stiffness, quantitative ultrasound SWE may be helpful in diagnosis and treatment response assessment for these disorders.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ruth C. Carlos, MD, MS - 2015 Honored EducatorKatherine E. Maturen, MD - 2014 Honored Educator

SSM11

Health Service, Policy and Research (Medical Practice Management)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S104B

HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Stephen Hobbs, MD, Lexington, KY (*Moderator*) Author with royalties, Wolters Kluwer nv
Melissa M. Chen, MD, San Antonio, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSM11-01 Clinical Utility Inpatient Abdomen MRI Following an Abdominal CT

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S104B

Awards
Student Travel Stipend Award

Participants
HeiShun Yu, MD, Boston, MA (*Presenter*) Nothing to Disclose
Gauruv S. Likhari, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
Peter F. Hahn, MD, PhD, Belmont, MA (*Abstract Co-Author*) Stockholder, Abbott Laboratories; Stockholder, Medtronic plc; Stockholder, CVS Caremark Corporation; Stockholder, Kimberly-Clark Corporation; Stockholder, LANDAUER, Inc; Spouse, Stockholder, Medtronic plc; Spouse, Stockholder, Gilead Sciences, Inc; Spouse, Bondholder, Bristol-Myers Squibb Company; Spouse, Bondholder, Johnson & Johnson
Debra A. Gervais, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Dushyant V. Sahani, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company; Medical Advisory Board, Allena Pharmaceuticals, Inc

PURPOSE

The purpose of this study was to assess the diagnostic yield of abdomen magnetic resonance imaging (MRI) in the inpatient setting following computed tomography (CT).

METHOD AND MATERIALS

All inpatient abdominopelvic MRIs performed on patients from October 1, 2014 to September 30, 2015 were identified and medical records were retrospectively reviewed for the following information: clinical impact of MRI on patient care and length of stay (LOS). Only MRIs with a preceding CT were included in the study.

RESULTS

A total of 221 MRIs were included. Forty exams were deemed technically inadequate due to motion while 9 more patients did not tolerate a full examination. The most common indications were focal liver lesion (n=101), pancreaticobiliary ductal dilatation (n=39), abnormal liver function tests (n=26), acute pancreatitis (n=14), abdominal pain (n=10) and fever/sepsis (n=9). Eighty-three (38%) MRI exams were recommended on CT and 138 (62%) were requests from the care team. In 63 (29%) cases, MRI offered new information over CT. Thirty-two MRIs recommended by radiologists affected patient management whereas only 31 MRIs (23%; p = .010) recommended by the care team affected management. Twenty-nine of these cases changed immediate inpatient management, requiring further intervention (IR drainage, ERCP or surgery) or changing medical therapy. MRI identified abscesses (n=17), choledocholithiasis (n=8) or confirmed cholecystitis (n=2), which were not confidently diagnosed on CT. Patient LOS increased in 24 patients in order to receive an MRI. The average scan time for inpatient MRI was 57 minutes compared to 35 minutes for an outpatient MRI.

CONCLUSION

Inpatient abdomen MRIs have limited impact on patient care following a CECT while they entail higher scan time, utilize more resources and increase patient LOS. Therefore, it is prudent to reserve MRI exams for select clinical indications in consultation with a subspecialty radiologist, allowing other exams to be performed on an outpatient basis, to maximize its value.

CLINICAL RELEVANCE/APPLICATION

In a climate of rising healthcare costs, we must be mindful when utilizing scarce resources, particularly abdominopelvic MRI, which may only be necessary in select indications.

SSM11-02 Diagnostic Performance of MRI for Differentiation of Papillary Renal Cell Carcinoma versus Non-Papillary Renal Tumors: A Systematic Review and Meta-analysis

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S104B

Awards
Student Travel Stipend Award

Participants
Matthew Chiarello, MD, New York, NY (*Presenter*) Nothing to Disclose
Stella Kang, MD,MSc, New York, NY (*Abstract Co-Author*) Author, Wolters Kluwer nv

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PURPOSE

To perform a systematic review and meta-analysis of the performance of MRI in differentiation of papillary-type renal cell carcinoma (RCC) from non-papillary renal tumors.

METHOD AND MATERIALS

We performed searches of three electronic databases from January 2000 through March 2017 for studies that utilized MRI techniques to differentiate papillary RCC from other renal lesions. Methodologic quality was assessed to identify potential sources of bias using QUADAS-2. Diagnostic performance was summarized quantitatively using bivariate random-effects modeling.

RESULTS

12 studies involving 1,382 patients and 343 papillary RCC lesions met inclusion criteria. The overall quality of studies was moderate. Six studies using relative tumor enhancement for papillary RCC prediction were pooled quantitatively, with overall sensitivity of 79.3% (95% CI, 62-90%) and specificity of 91.3% (95% CI,76.4-97.1%). All six studies used comparator groups of clear cell RCC and oncocytic tumors. These studies' performance characteristics demonstrated a threshold effect (rho = -0.5), supporting a tradeoff in sensitivity for specificity among the chosen quantitative enhancement thresholds, and therefore representation along a summary receiver operator characteristic (ROC) curve. The area under the summary ROC curve was 0.85. Inclusion of tumor T2 characteristics increased specificity from 84% to 95.6%. Three studies used signal loss on in-phase imaging to predict papillary RCC but marked statistical heterogeneity precluded pooling. There were less than 3 studies focused solely on use of tumor T2 signal characteristics compared with renal cortex or diffusion weighted imaging for papillary RCC prediction.

CONCLUSION

Meta-analysis supports moderate sensitivity and excellent specificity of tumor enhancement for differentiation of papillary RCC versus non-papillary renal tumors and further, prospective study of test accuracy may be warranted. The apparent heterogeneity in test performance among studies is accounted for in part by a tradeoff in sensitivity for specificity among the different enhancement thresholds selected for test positivity. Though requiring further study, inclusion of T2 signal characteristics of the renal tumor may further improve specificity.

CLINICAL RELEVANCE/APPLICATION

The high specificity of contrast-enhanced MRI for detection of papillary RCC among renal tumors may be useful in candidate selection for watchful waiting, given the general indolence of this tumor subtype.

SSM11-03 Piradsv2: Correlation with Clinical Risk Scores and Implications for Risk Stratification

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S104B

Participants
Florian Richter, MS, Dresden, Germany (*Abstract Co-Author*) Nothing to Disclose
Angelika Borkowetz, MD, Dresden, Germany (*Abstract Co-Author*) Nothing to Disclose
Verena Plodeck, MD, Dresden, Germany (*Abstract Co-Author*) Nothing to Disclose
Thomas Brauer, MD, Dresden, Germany (*Abstract Co-Author*) Nothing to Disclose
Manfred Wirth, Dresden, Germany (*Abstract Co-Author*) Nothing to Disclose
Michael Laniado, MD, Dresden, Germany (*Abstract Co-Author*) Reviewer, Johnson & Johnson
Ivan Platzek, MD, Dresden, Germany (*Presenter*) Nothing to Disclose

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PURPOSE

The aim of this study was to assess the relationship between PIRADSv2 scores and clinical risk scores in patients with prostate cancer and thus evaluate the potential role of the PIRADS score in risk stratification.

METHOD AND MATERIALS

Two hundred patients with suspected prostate cancer were included in this retrospective study. Patient age varied between 41 and 82y (66y on average). The mean prostate-specific antigen level (± SD) at the time of the biopsy was 10.52 ± 9.0 ng/ml. All patients underwent multiparametric prostate MRI (mpMRI) at 3T. The PIRADSv2 scoring system was used for MRI lesion classification. All patients underwent MRI/ultrasound fusion-guided biopsy. Based on the biopsy results and additional parameters (PSA value, clinical stage, count of positive biopsy punches etc.) the following clinical risk scores were calculated for each patient: D'Amico score, UCSF-CAPRA score and Epstein Criteria. The relationship between the maximum PIRADS score and the clinical risk scores was analyzed using a logistic regression model and Tukey's range test as a post-hoc test.

RESULTS

The highest PIRADS score was 5 in 35/200 patients, 4 in 62/200 patients, 3 in 66/200 patients and 2 in 27/200 cases. In 10/200 patients no lesions could be identified based on MRI. PIRADS scores of 5 ($p < 0.001$) and 4 ($p < 0.01$) were shown to be significant predictors for all three clinical risk scores, while maximum PIRADS scores of 1, 2 or 3 were not significant predictors. Patients with a PIRADS score of 5 had significantly higher clinical risk scores than patients with a maximum PIRADS of 1, 2 or 3 (D`Amico: $p < 0.001$; UCSF-CAPRA: $p < 0.001$; Epstein: $p < 0.001$), while there was no significant difference between PIRADS 4 and lower maximum PIRADS scores. Among patients with PIRADS 5, the percentage of high-risk cases was 86.3% according to the D'Amico score, 90.2% according to UCSF-CAPRA and 94.1% according to the Epstein Criteria.

CONCLUSION

A PIRADS score of 5 is a significant predictor for the three evaluated clinical risk scores. A PIRADS score of 5 is associated with significantly higher clinical risk scores than maximum PIRADS 1, 2 or 3. Patients with a PIRADS score of 5 include a large precentage of high-risk prostate cancer cases.

CLINICAL RELEVANCE/APPLICATION

The results imply that a PIRADS score of 5 can help identify high-risk prostate cancer cases even before the tumor is confirmed by biopsy.

SSM11-04 MRI Orders Prioritization and Associated Effects on Appropriate Utilization of MRI at a Large Public Hospital

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S104B

Awards
Student Travel Stipend Award

Participants
Anna Trofimova, MD, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose
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PURPOSE

To determine changes in MRI order prioritization and downstream effects on appropriate utilization of MRI at a large public hospital from 2012 to 2015.

METHOD AND MATERIALS

Retrospective IRB approved study of MRI exams (MRIs) performed at a large public hospital from 2012 to 2015. The following parameters were analyzed: total number of MRIs; number of STAT and routine MRIs; type of MRI exams; ordering hospital services; mean total turnaround time (MTAT) for different MRIs per month; for MRIs performed in 2015 - per the day of the week and time of the day when the order was placed. The analyzed data were used to develop an on-line survey distributed to ordering providers to assess their knowledge of the order priority policy and evaluate factors which contribute to decision making in prioritization of MRI orders.

RESULTS

From 2012 to 2015 the total number of MRIs have increased by 35% reaching 10921 in 2015. STAT MRIs increased by 76%, routine MRIs increased by 12%. STAT MRIs increased by 72% for outpatients, 132% for inpatients and decreased by 35% for ER patients. MRI of the brain, lumbar spine and head/neck MRA represented 58% of all MRIs scans. The total number of brain MRIs increased by 38%, STAT brain MRIs increased by 82%, routine brain MRIs increased by 2%. 5 out of 89 hospital services ordered 70% of brain MRIs and 70% of those were ordered STAT. In 2015 MTAT for STAT brain MRI was 52% higher than for routine orders. MTAT is significantly affected by month of the year for STAT brain MRI, for routine brain MRIs MTAT is significantly higher for orders placed on Sunday and from 7 pm till 8 am. 97 providers (36% faculty; 64% trainees) completed the survey. Only 4% of responders were familiar with the timing of the STAT MRI order per hospital policy with significant difference as a function of specialty and level of training. Prevalent expectations for time to complete STAT MRI was "same day" for ER and inpatient and "2-3 days" for outpatient MRI orders.

CONCLUSION

Misuse of order priority system leads to disproportionate increase in STAT MRI orders with STAT brain MRI total turnaround time being 52% higher than routine brain MRI.

CLINICAL RELEVANCE/APPLICATION

Inappropriate MRI order prioritization significantly affects diagnostic imaging resources utilization and decreases quality of patient care by increasing turnaround time when STAT MRI is indicated.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Elizabeth A. Krupinski, PhD - 2017 Honored Educator

SSM11-05 Improvement of Provider and Patient Satisfaction in a Large Outpatient Imaging Practice Following Practice-Wide Implementation of a Structured Service-Excellence Training Program

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S104B

Participants
Monica Salama, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
Joseph R. Steele Jr, MD, Houston, TX (*Abstract Co-Author*) Consultant, Adient Medical Inc; Stockholder, Adient Medical Inc;
Habib Tannir, MS, Houston, TX (*Presenter*) Nothing to Disclose

PURPOSE

Low patient satisfaction scores and the need to improve upon referrals prompted us to address the experience we were providing. The implementation of our Service Excellence Academy (SEA) has already led to measurable improvement in our scores, increased

collaboration and positively charged our work environment.

METHOD AND MATERIALS

Informal interviews with providers showed they believed they were providing excellent service, but Press-Ganey scores showed patients did not always perceive the service as excellent. To improve providers' understanding of what patients and family members consider excellent service and thereby improve patient satisfaction, we created the SEA by evaluating best practices of service leaders across industries, and applying the strategies to our culture and healthcare setting. This ten-hour, three-module program was designed as an interactive discussion, leveraging clinical examples and role-playing. Sessions were led by one content expert and a member of leadership. The involvement of the leadership connected real examples and demonstrated their commitment to the culture shift.

RESULTS

Since launching the SEA in 2015, we have seen our outpatient survey scores stabilize, rise and recover from outside influences. All metrics show percentile improvement ranging from 9% to 34%. We are also using our employee survey as a benchmark to establish if we have affected the environment we create for ourselves. Finally, we collected feedback before, during and after the sessions to validate the engagement and buy-in of the participants. Participants felt a greater connection with the institutional culture, were more comfortable making decisions, felt more empowered and had developed greater empathy and skills to meet the needs of others.

CONCLUSION

Large scale training of providers and staff is possible and effective. Implementation of the SEA demonstrated both objective and subjective improvement of the patient and employee satisfaction. We have implemented strategies to build upon relationships and empowered our team members to make this a living part of our culture that continues to adapt, grow and improve our outcomes. This program is now being adapted for institutional implementation.

CLINICAL RELEVANCE/APPLICATION

Open lines of communication create an environment where colleagues are more inclined to consult on challenging cases, or proactively discuss options before ordering, resulting in better outcomes.

SSM11-06 Implementing a Comprehensive System to Optimize Performance on the Quality Payment Program of MACRA Across a Multi-Site Practice

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S104B

Participants
Richard E. Heller III, MD, Chicago, IL (*Presenter*) Nothing to Disclose
Basak Ertan, El Segundo, CA (*Abstract Co-Author*) Nothing to Disclose
Nina E. Kottler, MD, MS, Sydney, Australia (*Abstract Co-Author*) Nothing to Disclose
Abraham J. Bronner, MD, Harvey, IL (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The Medicare Access and CHIP Reauthorization Act (MACRA) of 2015 revised the system used by the Centers for Medicare and Medicaid Services (CMS) to pay physicians for care provided to Medicare patients [1]. The Quality Payment Program (QPP), created by MACRA, is intended to incentivize providers to deliver care that increases value and improves quality and/or lowers cost [2]. The QPP specifies four performance categories, each containing various numbers of required measures. Performance above a threshold will result in a bonus payment. Poor performance, or non-participation, will result in payment deductions, with these payment changes beginning in 2019. The program is intended to be budget neutral, meaning that the penalties fund the bonuses. Our radiology group, consisting of locally-led practices with over 350 radiologists serving more than 260 sites in nine states, developed a comprehensive, robust, and adaptable program to manage performance on these measures. The size of our practice provided both challenges and opportunities. The practice has the scale to invest in resources to optimize our performance, but simultaneously the large and multi-centric nature of our practice makes coordination more challenging. The primary goal of our program is to support our broader practice mission of enhancing value for healthcare systems and improving patient care. This is done alongside the financial incentives created by MACRA and the QPP. This presentation describes our approach and the development of our MACRA program.

RESULTS

For each practice, the above questions were answered and a spreadsheet was created (Figure). The figure lists several of our sites, as well as the pace they are reporting at, their patient-facing status, and which measures in the four performance categories they are reporting. Note that we are only reporting on Quality and Improvement Activity measures. Since no practice (radiology or otherwise) has to manually report Cost data, no requirements for this performance category were included. Additionally, since all of our practices are considered non-patient-facing, which has a reduced reporting burden including exclusion from the fourth performance category, Advancing Care Information, no measures here are reported.

CONCLUSION

We have described a comprehensive program for management of the Quality Payment Program created by MACRA, and the various measures required of physicians who provide services to Medicare patients. As the financial implications of the QPP are substantial, starting with a +/- swing of four percent in 2019 and quickly escalating, medical practices serving Medicare patients must have a robust program to manage the complex system with its numerous and still evolving variables. In addition, the intuition behind MACRA, that is payment for better and more value-based care, supports our broader practice goals of enhancing value and improving patient care.

METHODS

Our process has three main components. First, we created a diversified team to develop and manage our MACRA program. Second, we reviewed the necessary decisions and then determined how to best match the reporting requirements with the goals of our

program and our practice strengths. Finally, we established an education program along with performance tracking to ensure optimal and consistent achievement of the desired measures. We initially created a multi-disciplinary team to develop and manage our MACRA program. The team is led by the chief revenue officer, someone with extensive experience in healthcare revenue cycle management. The other members of the team include physicians, support analysts, billing and coding specialists, and information technology (IT) personnel. Another skillset, which was provided by the physician liaisons, was societal and policy affairs expertise. This was felt to be crucial as our practice recognizes the importance of working in conjunction with the American College of Radiology. The team then set about determining the key questions and answering them. This includes: 1) Will each practice report as patient-facing or non-patient-facing? 2) Should the local sites report as a group or as individuals? 3) Which measures should each site report on? 4) How will the measures be reported (claims or registry)? 5) What pace should each local practice choose to report at? Each of these five questions had to be answered for every local practice. We then developed an educational program for our radiologists. This was composed of three live web-based seminars, group emails, and posts on our internal practice website. Radiologists were given opportunities to ask questions, raise concerns, and make suggestions. After education, we began tracking performance through use of analysts and IT solutions. We provide monthly feedback to the practices on their performance in the form of a scorecard.

PDF UPLOAD

https://abstract.rsna.org/uploads/2017/17013906/17013906_mdyx.pdf

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
Explore Invent Transform

SSM12

Informatics (Machine Learning in Radiology)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S404CD

IN RS

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Norio Nakata, MD, Tokyo, Japan (*Moderator*) Nothing to Disclose
Nabile M. Safdar, MD, Milton, GA (*Moderator*) Nothing to Disclose
Luciano M. Prevedello, MD, MPH, Columbus, OH (*Moderator*) Nothing to Disclose

Sub-Events

SSM12-01 An Artificial Intelligence Method for Auto-Contouring in Abdominal Magnetic Resonance Imaging-Guided Adaptive Radiation Therapy

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S404CD

Participants
Fan Liang, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Pengjiang W. Qian, PhD, Wuxi, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Manual contouring remains the most laborious task in radiation therapy planning and is a major barrier in implementing routine Magnetic Resonance Imaging (MRI) guided-guided Adaptive Radiation Therapy (MR-ART). To address this, we propose a new artificial intelligence-based auto-contouring method for abdominal MR-ART modeled after human brain cognition for manual contouring.

METHOD AND MATERIALS

Our algorithm is based on two types of information flow: top-down and bottom-up. Top-down information is derived from simulation MR images. It grossly delineates the object based on its high-level information class by transferring the initial planning contours onto daily images. Bottom-up information is derived from pixel data by a supervised, self-adaptive, active learning based support vector machine. It uses low and middle level pixel features such as intensity and location to distinguish each target boundary from the background. The final result is obtained by fusing top-down and bottom-up outputs in a unified framework through fuzzy logic. For evaluation, we used a dataset of four patients with locally-advanced pancreatic cancer treated with MR-ART using a clinical system (MRIdian, Viewray, Oakwood Village, OH). Each set included the simulation MRI and on-board T1 MRI corresponding to a randomly selected treatment session. Each MRI had 144 axial slices of 266×266 pixels. Using Dice Similarity Index (DSI) and Hausdorff Distance Index (HDI), we compared manual and automated contours for liver, left and right kidney and spinal cord.

RESULTS

Average auto-segmentation time was 2 minutes per set. Visually, the automatic and manual contours were similar. Fused results achieved better accuracy than either the bottom up or top down method alone. DSI values were above 0.82±0.03, except for the spinal canal. The spinal canal contours yielded a low HDI value at the expense of a relatively low DSI value.

CONCLUSION

With a DSI significantly higher than the usually reported 0.7, our novel algorithm yields a high segmentation accuracy. To our knowledge, this is the first fully automated contouring approach using T1 MRI images for adaptive radiotherapy.

CLINICAL RELEVANCE/APPLICATION

Minimal computational time coupled with high accuracy make our algorithm ideal for the MR-ART implementation thus minimizing the time gap between image acquisition and radiation delivery.

SSM12-02 Personalized Survival Prediction Using Random Forest Survival Model on MR Radiomic Features in

Gliomas

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S404CD

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PURPOSE

To determine the feasibility of personalized survival prediction using MR radiomic features for patients with glioma.

METHOD AND MATERIALS

The MRI and survival data of 178 subjects with primary glioma were obtained from the Cancer Imaging Archive, including 100 glioblastoma data from the TCGA-GBM collection and 78 lower-grade glioma (grade II or III) data from the TCGA-LGG collection. This dataset was randomly partitioned into two subsets, 80% for model training (142 subjects) and 20% for validation (36 subjects). MRI, pathology, and DNA data (IDH and 1p/19q status) of 8 patients with primary glioma were recruited from local hospitals to further test the constructed prediction model. MR radiomic features were calculated from the postcontrast T1 weighted images and apparent diffusion coefficients based on the previously proposed approach. A Random Forest Survival model was constructed using the MR radiomics as predictors. The most informative predictors (260 of 868 features) was selected based on their hierarchy in the decision trees, i.e. the importance scores among all the predictors.

RESULTS

The receiver operating characteristic curves on the validation data (36 subjects) showed a promising prediction performance of the proposed survival model with the area under the curve between 0.826 and 0.971 at different time points after diagnosis. The personalized survival prediction on the 8 testing patients also provided plausible predictions in concordance with the current understanding of the prognosis in different grading, IDH, and 1p/19q status. The only exception is a grade III glioma (subject #2) who had a poorer survival prediction than glioblastoma. The real survival of recruited patients will be recorded by continuous monitoring to verify the proposed model.

CONCLUSION

The established survival prediction model based on MR radiomics is feasible and can be used to promote the personalized medicine of prognosis and treatment strategy in glioma.

CLINICAL RELEVANCE/APPLICATION

Predicting individual survival by efficient MR radiomics and machine learning can benefit the healthcare in patients with glioma from providing a reliable prognosis without high-cost gene assays.

SSM12-03 Automatic Cancer Staging from PET/CT Reports for Large Cohort Studies Using Natural Language Processing and Machine Learning

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S404CD

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PURPOSE

To evaluate supervised machine learning (ML) algorithms for automatic cancer stage classification of >12'000 patients based on the radiology report.

METHOD AND MATERIALS

The radiology reports of >12'000 FDG-PET/CT exams between 2007 and 2014 were extracted from the hospital database. A randomly selected set (n = 1254) was manually read and split into subsets for training (80%) and testing (20%). Each report was assigned to one of five distinct cancer stages: 0 = No cancer, 1 = minimal/inactive residual, 2 = single tumor, 3 = locally advanced

disease, 4 = distant metastasis. The reports were preprocessed using basic natural language processing (NLP) techniques. Five common ML classifiers were evaluated: Naive Bayes Classifier (NBC), Support Vector Machines (SVM), Decision Trees (DTC), Random Forest (RFC), and K-nearest neighbors (KNN). Performance was expressed as area under the receiver operating curve (Az) obtained by stratified 10-fold cross-validation of the training set as well as the classification accuracy of the test set.

RESULTS

The number of reports assigned to each stage showed the following distribution: n0=324, n1=336, n2=161, n3 = 142, n4=291. SVM exhibited the best performance in the training set (Az = 0.90 / 0.87 / 0.81 / 0.87 / 0.91 for class 0/1/2/3/4, respectively), followed by NBC (0.88 / 0.86 / 0.79 / 0.85 / 0.90), RFC (0.85 / 0.73 / 0.75 / 0.81 / 0.88), KNN (0.85 / 0.79 / 0.74 / 0.80 / 0.82) and DTC (0.70 / 0.59 / 0.55 / 0.64 / 0.70). Mean classification accuracy of the test set was highest for NBC (0.57), followed by SVC (0.55), RFC (0.5), KNN (0.48) and DTC (0.45). Classification for the whole cohort was feasible with all classifiers.

CONCLUSION

Automatic detection of cancer stages was feasible with all tested ML methods. SVM and NBC performed best among the tested classifiers.

CLINICAL RELEVANCE/APPLICATION

Automatic cancer staging from radiology reports using natural language processing and supervised machine learning is a useful tool for the creation of large cohort studies.

SSM12-04 Semantic Image Segmentation in Breast MR Image with Deep Convolutional Neural Network

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S404CD

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PURPOSE

To propose and validate the semantic segmentaion method with deep-learning in breast MR images to differentiation of various kinds of tissues for deformation modeling of breast parenchyma with tumor and 3D printing.

METHOD AND MATERIALS

This research is an advanced task for 3D printing and prediction of deformation model of breast parenchyma with tumor between prone and supine position. At first, it is necessary to segment the image on the regions of interest accurately. For the segmentation model of CNN, 10 volumetric breast MR images with prone and supine position of a patient were collected and drawn with five areas (background, lung_heart, muscle_bone, parenchyma_cancer, fat_skin) manually by an expert. The data were split into 8 subjects for training and 2 subjects for validation. Because of no significant change in the axial direction, each subject was considered as 2D images with axial direction so that it was trained with 1732 images and validated with 410 images. And we constructed segmentation model based on U-net. However, U-net showed low performance in this task so that the structures were overall modified and the batch normalization was added. Because it is somewhat similar between prone and supine position images, we compared network trained each position image with sum of them. To calculate accuracy and loss, we used the dice coefficient. Although it trained with axial 2D images, we evaluated the performance with 3D volume results to measure accurately. In addition, the accuracies were measured on each class, because each class has different quantity in the 3D volume.

RESULTS

Building the ground truth took 4-5 hours per subject, while it took about 20 seconds per subject with NVIDIA TITAN X. The result which is predicted with network trained each position image was higher than sum of them. The total accuracy is about 98% on whole cases. In addition, it shows the lowest accuracy on the parenchyma_cancer class as supine-86 % and prone-90 % on average) because it has large variation.

CONCLUSION

We applied semantic segmentation method for breast MR image, and it showed high performances to segment on our regions of interest and greatly reduced time as compared with manual process.

CLINICAL RELEVANCE/APPLICATION

This segmentation method can be used to differentiation of various kinds of tissues for deformation modeling of breast parenchyma with tumor in breast MR images between prone and supine position.

SSM12-05 A Clinically-Actionable Fully Convolutional Network for Brain Tumor Segmentation

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S404CD

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PURPOSE

We propose a fully convolutional network (FCN) for glioblastoma (GBM) segmentation using MRI data that has very few tunable parameters, making easy to drop in to clinical applications.

METHOD AND MATERIALS

We tackle the task of using an algorithm to automatically segment three-dimensional MRI images of GBM patients' brains-classifying each voxel of the image as cancerous--regions of edema, necrosis, and active tumor-or not. Our network uses six convolutional layers with true three-dimensional filters, followed by a voxel-wise softmax classifier. Our pre-processing pipeline is parameter-free and only depends on the voxel values of the input MRI image. We forgo post-processing and use the raw outputs of the network as our output segmentations. We trained and validated our network using MRI and ground-truth expert segmentation data from the BRATS 2015 dataset. This dataset contains 220 examples, and we used 75% of these for training and the remaining 25% for validation.

RESULTS

For the cancerous vs. non-cancerous task, with a 75%/25% training/validation split and no post-processing, we achieve the following validation results. We achieve an average Dice score of 0.865, an average Jaccard score of 0.771, and an average overlap score of 0.927. In the attached figure, we provide a histogram of validation Dice scores for the cancerous vs. non-cancerous task with four-fold cross-validation. For comparison, the average pairwise Dice score between the eleven experts who put together the ground truth data is 88%.

CONCLUSION

The proposed FCN algorithm performs almost as well as human experts and represents a segmentation solution that is clinically actionable. It can be used seamlessly in a clinical diagnostic environment with very little manual tuning.

CLINICAL RELEVANCE/APPLICATION

Accurate, automatic medical image algorithms like the proposed segmentation technique can assist radiologists in their interpretation of medical images.

SSM12-06 Automatic Classification of Acute Ischemic Stroke Patient within 4.5 Hours Symptom Onset: Comparison between Deep and Shallow Learning Approaches

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S404CD

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PURPOSE

Determination of symptom onset time for acute ischemic stroke is crucial because the treatment options highly depend on time window. Here, we propose automatic methods based on deep learning (DL) which is the state of art of machine learning and support vector machine (SVM) to classify acute ischemic stroke patients within 4.5 hours symptom onset and compare their performances.

METHOD AND MATERIALS

We retrospectively evaluated 214 patients within 24 hours of symptom detection and underwent 1.5T magnetic resonance imaging (MRI). Some patients were excluded due to missing MRI sequences (22), low image quality (3), false infarct segmentation (7), or small infarct size (33 and 42 for SVM and DL). Finally, 140 and 149 patients were analyzed for the DL and SVM, respectively. Infarct legions were automatically segmented on apparent diffusion coefficient (ADC) maps by applying adaptive thresholding based on histogram normalization. Fluid attenuated inversion recovery (FLAIR) images were registered into the corresponding ADC map. For DL, only axial slices containing infarct regions were used as inputs of Inception V3 network. For SVM, image features including intensity, gradient, and texture information were extracted from infarct regions. The classifier parameters were tuned based on F0.5 and class weights to obtain good specificity.

RESULTS

A 5-fold cross-validation was conducted for training and testing of DL and SVM. For using single modality, accuracy and sensitivity of DLs are significantly higher than those of SVMs ($p<0.05$, t-test), with a similar level of specificity. The DL using all of three modalities tended to show significantly better performance in terms of accuracy (0.88 ± 0.02), sensitivity (0.95 ± 0.04), and specificity (0.78 ± 0.04), except sensitivity of ADC (0.96 ± 0.05).

CONCLUSION

We proposed the automatic classification systems for acute ischemic stroke patients within 4.5 hours of symptom onset using deep and shallow learning methods. In results, the DL showed good identification of acute ischemic stroke patients within 4.5 hours of symptom onset.

CLINICAL RELEVANCE/APPLICATION

The proposed classification systems might be useful for identifying unknown-onset stroke patients who could be candidates for

reperfusion therapy.

SSM13

Molecular Imaging (Analysis and Quantification)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S504CD

BQ MI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSM13-02 Quantification of Adipose Tissue and Organ Fat Content Using Whole-Body Dixon Fat-Water Separation Technique

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S504CD

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PURPOSE

The purpose of this study is to utilize whole-body Dixon fat-water separation technique to quantify adipose tissue (AT) distribution and fat content of different organs, to investigate characteristics of fat distribution, and to determine whether these quantitative parameters are risk factors of metabolic syndrome (MS).

METHOD AND MATERIALS

We recruited 39 male volunteers and 71 female volunteers, with an average age of 58.7±9.1 years and an average BMI of 26.1kg/m2, among which 19 female and 11 male volunteers were diagnosed with metabolic syndrome. Whole-body fat and water images were acquired using a Dixon-VIBE sequence on MAGNETOM Skyra 3T MR scanner. Scan parameters were as follows: TR 5.26ms, TE 1.24ms, Flip angle 9°, FOV 500mm x 500mm, 44-60 slices,slice thickness 5.0mm, total acquisition time 60s. ImageJ software was applied to measure the volume of intra-thoracic AT (ITAT), intra-abdominal AT (IAAT), truncal subcutaneous AT (TSAT), and lower limb AT (LLAT). Osirix software was utilized to measure fat fraction(FF) of liver, pancreas, L2-L4 vertebral bodies, and skeletal muscle of lower limbs.

RESULTS

Compared with female group, male volunteers possessed more ITAT and IAAT, less TSAT, LLAT and total adipose tissue (TAT), and a higher ratio of IAAT (IAAT%). The senior group (>=60 years old) contained more ITAT, IAAT, and IAAT% than the junior group (<60 years old). Compared with premenopausal females, post-menopausal females had less TAT, more ITAT, and higher IAAT%. FF of skeletal muscle in lower limbs was higher in senior, female, and postmenopausal groups. FF of the vertebral body was higher in post-menopausal groups. Multiple binary logistic regression analysis demonstrated that volume of IAAT was a risk factor for MS.

CONCLUSION

The Dixon fat-water separation technique can be used to quantify whole-body adipose tissue and fat fraction of different organs. Distribution of adipose tissue and organ fat fraction varied in different sex and age groups. Accumulation of intra-abdominal adipose tissue may increase the risk of developing metabolic syndrome.

CLINICAL RELEVANCE/APPLICATION

This technique allows precise quantification of whole-body fat, which may enable the individualized diagnosis and evaluation of diseases with mal-distribution of adipose tissue or fat content.

SSM13-03 CEST MRI of Surgically-Removed Prostate Correlates with Histological Stratification

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S504CD

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PURPOSE

While muiltiparametric MRI combining T2-weighted (T2-w) imaging with functional imaging techniques can provide moderate sensitivity and specificity for diagnosis of prostate tumor, there is still a great need in developing novel MRI methods for reliable risk stratification of prostate lesions. Chemical exchange saturation transfer (CEST) MRI as an emerging metabolic and molecular MRI method based on endogenous tissue contrasts has been demonstrated to assess aggressiveness of brain tumor. The aim of this study was to investigate the value of CEST MRI in the risk stratification of prostate pathologies. To pave the path for in vivo clinical studies, this study was initiated by scanning whole surgically-removed prostates with high resolution and correlating with the corresponding pathological images.

METHOD AND MATERIALS

Under an approved IRB protocol, whole prostate specimens from patients (n=5, 62±3 yrs) were studied immediately after surgery. MRI was performed on a horizontal 9.4-T animal MRI scanner with a commercial volume coil (72 mm in diameter). T2-w fast spin echo and diffusion-weighted images (DWI) were acquired. In addition, ADC was constructed from DWI images. CEST Z-spectra were then collected using a customized sequence with a frequency-selective saturation pulse (B1 = 100 Hz, 2 s). CEST data was corrected for static field B0 inhomogeneity. CEST asymmetry contrast was computed and normalized by signal at +100 ppm. Immediately after MRI, the specimens were processed for histopathological studies. Prostate lesions and Gleason patterns were prescribed by a clinical pathologist on histological images (H&E stained) from the slices close to the MR imaging planes.

RESULTS

By comparing the CEST contrast maps with the corresponding histological images, we found CEST contrast in tumor was significantly lower than that of normal tissue (4.8±0.1 vs. 6.5±0.3 %, $p<0.05$). On the other hand, CEST contrast in benign prostatic hyperplasia (BPH) (12.7%) was much higher than that of both normal tissue and tumor. In general, CEST contrast maps demonstrated a close correlation with regional Gleason patterns in histological images.

CONCLUSION

CEST MRI contrast, once further confirmed with a large sample size and in vivo clinical studies, may have great potential for risk stratification of prostate pathologies.

CLINICAL RELEVANCE/APPLICATION

CEST MRI has the clinical potential for characterization of prostate diseases.

SSM13-04 Utilizing Radiomics to Differentiate Hot and Cold Tumor Immune-Microenvironment in Biopsy-Proven Malignant Melanoma: A Pilot Study

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S504CD

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PURPOSE

An immunogenic tumor microenvironment (hot) is a strong and independent predictor of improved patient outcome. Additionally, new immune checkpoint inhibitor therapies can activate anti-tumor immune response and trigger an immune-infiltration which is responsible for the pseudoprogression phenomenon. Pseudo-progression masks effective therapy efficacy since a transitory increase in tumor volume is observed. We aimed to explore if radiomics can predict the immune-infiltration profile in malignant metastatic melanoma patients treated with immune checkpoint blockade by anti-PD-1.

METHOD AND MATERIALS

We retrospectively recruited metastatic melanoma patients treated with anti-PD1. All patients had a contrast-enhanced CT-scan as well as a tumor biopsy with a 360 gene panel RNA-expression profile. We divided patients in two categories: hot and cold tumor immune microenvironment. "Hot" was defined by a quantitative expression of RNA above the median in at least two out of four key immune pathways: cytotoxic lymphocytes (CD8A and CD8B), human inducible T-cell co-stimulator (ICOS); and interleukin 2 (IL2). We contoured the tumor lesions in 3D and extracted 89 radiomic imaging features. Area under the curve (AUC) calculated the accuracy of imaging features for the detection of hot immune infiltration.

RESULTS

61 lesions in total were contoured: 33 hot and 28 cold. The two best imaging features for the detection of a hot immune infiltration were Entropy of Grey Level Concurrence Matrix and Skewness. Their respective AUCs (95CI; p-value) were: 0.75 (0.62-0.88; P=0.001) and 0.74 (0.60-0.88; P=0.001). Combining these two features, a correct classification of hot vs. cold (95CI) was achieved in 77% (65-87%) of lesions.

CONCLUSION

This pilot study provides proof of concept regarding an association between tumor imaging phenotype assessed by radiomics on CT-scan and the presence of a hot tumor immune infiltration according to biopsy RNA-sequencing. Prospective validation in larger cohorts is warranted.

CLINICAL RELEVANCE/APPLICATION

The classification of tumor immune microenvironment by imaging biomarkers could provide prognostic information and improve response assessment accuracy, especially in immuno-oncology.

SSM13-05 Using the Least Solid State Detectors to Achieve the Most: Pushing the Envelope of Digital Photon Counting TOF PET by Simulating Sparse-Ring Configuration

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S504CD

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PURPOSE

To leverage and go beyond accepted conventions in PET detector designs by investigating the new generation solid state digital photon counting (DPC) PET detectors in simulated sparse-ring PET configuration for oncologic FDG PET/CT

METHOD AND MATERIALS

A solid state DPC PET/CT system (Vereos) with 23,040 individual crystal-to-SiPM detector couplings (18 fiat modules, 4 tangential by 5 axial array tiles on each, 8x8 matrix pixels on each tile) was used. Investigational wholebody FDG PET/CT of 10 oncology patients were performed (13.1±0.4mCi FDG; 75±5min p.i). PET was reconstructed using 3D TOF OSEM in 4x4x4mm3 using A) full ring data, and sparse-ring PET simulation by disabling B) 1 pixel of every 2 pixels in tangential (50% crystal-detector reduction), C) 1 of every 3 pixels in tangential (33% reduction), D) 1 of every 4 pixels in tangential (25% reduction) and E) the 2nd and 4th entire rings in axial (40% reduction). NEMA phantom with hot spheres was performed using the same approaches. All results were compared and analyzed to assess image quality (IQ) and PET quantification

RESULTS

All lesions on the full-ring PET were visible on sparse-ring PET simulation (C)-(E). though most lesions were identifiable on sparse-ring PET in (B), artifacts appeared. Reducing the number of crystal-detector couplings to 25% (D) maintained PET IQ without giving significant SUV variances compared to full-ring PET ($p<0.01$). Keeping detector rings intact in tangential with 40% detector reduction in axial using (E) surprisingly demonstrated good results without compromising much of IQ. Applying counts-adaptive reconstructions by optimizing recon parameters further improved PET IQ. Radically either up to 40% cost can be saved or up to 40% axial FOV can be extended without adding new detectors. Comprehensive data assessment will be presented

CONCLUSION

1:1 coupling of crystal:detector DPC PET is a technology leap however with trade-off of high cost limited axial FOV. The study challenged its current designs and pushed the envelope to go beyond its boundaries in improving axial FOV and system sensitivity without adding additional cost by sparse-ring PET simulation.

CLINICAL RELEVANCE/APPLICATION

Solid state digital PET is a technology leap with great potentails of using least solid state detectors to achive the most without adding cost while retaining reliable image quality for oncology PET and the study investigated this using sparse-ring PET simulation.

SSM13-06 Texture Analysis of 68Ga-DOTATATE Positron Emission Tomography and Computed Tomography Images as a Prognostic Biomarker in Adults with Neuro-Endocrine Cancers Treated with 177Lu-DOTATATE

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S504CD

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PURPOSE

Neuroendocrine tumors (NETs) are a rare, heterogeneous group of cancers whose behavior can be hard to predict. A better understanding of prognosis would aid individualized management decisions. We aim to demonstrate the prognostic potential of tumor heterogeneity and avidity in NETs using PET and CT textural analysis (PTA & CTTA) and standardized uptake values (SUV).

METHOD AND MATERIALS

The baseline 68Gallium-DOTATATE PET/CT scans of 49 prospectively recruited patients with NETs (carcinoid, pancreatic, thyroid, head and neck, catecholamine-secreting and unknown primary tumors) treated with 177Lutetium-DOTATATE at a tertiary center were retrospectively analyzed. Non-contrast CT and PET heterogeneity was assessed using a commercially available TexRAD texture analysis software (TexRAD Ltd www.texrad.com, part of Feedback Plc, Cambridge, UK) which employed a filtration-histogram technique. Regions of interest encircled the most prominent metastases of each patient (up to 5 tumour foci) as seen on the 68Ga-DOTATATE PET scan. Gallium uptake on PET was quantified as SUVmax and SUVmean. Association between imaging and clinical markers with progression-free (PFS) and overall survival (OS) were assessed using univariate Kaplan-Meier and multivariate Cox regression analysis.

RESULTS

Clinical factors did not generally predict survival. Measures of texture heterogeneity (quantified as skewness and kurtosis) on unfiltered and filtered (fine-medium texture scale) CT and unfiltered PET images predicted PFS (CT: p=0.0126, PET: p=0.0047) and OS (CT: p=0.0061, PET: p=0.0028). Furthermore patients with SUVmax >8.73 and SUVmean >5.19 showed significantly superior PFS (p=0.0164) and OS (p=0.0061). Multivariate analysis identified that CTTA (fine texture scale - skewness: HR=6.98, 95%CI=2.281-21.372, p=0.001) and SUVmax (HR=4.439, 95% CI=1.679-11.739, p=0.003) were independent predictors of PFS. PTA (without filtration skewness : HR=20.68, 95%CI=3.24-131.99, p=0.001) was an independent predictor of OS.

CONCLUSION

68Ga-DOTATATE PET/CT texture heterogeneity and SUV measurements could act as prognostic biomarkers in NETs and potentially play a key role in risk stratifying these patients.

CLINICAL RELEVANCE/APPLICATION

68Ga-DOTATATE PET/CT texture heterogeneity analysis and SUV measurements independently predict survival in NETs. Their role as prognostic biomarkers could significantly improve stratification of NET patients.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
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SSM14

Musculoskeletal (Ultrasound)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353C

MR MK US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants

Mary M. Chiavaras, MD, PhD, Ancaster, ON (*Moderator*) Nothing to Disclose
Kenneth S. Lee, MD, Madison, WI (*Moderator*) Grant, General Electric Company; Research support, SuperSonic Imagine; Research support, Johnson & Johnson; Consultant, Echometrix, LLC; Royalties, Reed Elsevier

Sub-Events

SSM14-01 Ultrasound-Guided Treatment of Calcific Tendinitis of the Rotator Cuff: Efficacy of Percutaneous Lavage Using Sodium Hexametaphosphate (SHMP) in Comparison with Simple Saline

Wednesday, Nov. 29 3:00PM - 3:10PM Room: E353C

Participants
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PURPOSE

To determine the efficacy of percutaneous US-guided needle lavage of symptomatic rotator cuff calcifications using a sodium hexametaphosphate (SHMP) solution (0.5%), in comparison with the same technique using simple saline

METHOD AND MATERIALS

We evaluated 24 calcifications (4 type A, 11 type B, 9 type C according to Gartner classification, mean size 24.7mm, range 9-31mm) in 24 patients (13 males, 11 females, mean age 34.8 years). Patients were divided into 2 groups and treated by percutaneous fragmentation and lavage using SHMP (Group 1, 12 patients) or simple saline (Group 2, 12 patients). Pre- and post-procedure (at 2 and 4 weeks follow-up) imaging evaluation was performed in all patients, including conventional radiography (RX) and ultrasound (US) examination to assess location, size and type of calcifications. Imaging findings after treatment were evaluated by two independent raters and defined as "partial" or "subtotal" dissolution. Pre- and post-procedure clinical evaluation (at 2 and 4 weeks follow-up) was assessed using the Constant Shoulder Score for functionality and the VAS Score for pain

RESULTS

The two study groups were homogeneous in terms of patient demographics, size and type of calcifications. 2 weeks after treatment in Group 1 we found subtotal dissolution of calcifications in 8 patients (66.7%) and partial dissolution in 4 (33.3%); of these, 2 (50%) showed subtotal dissolution at the 4 weeks follow-up. In Group 2 we found subtotal dissolution in 58.3% and partial in 41.7% ($p<=0.05$). 1 patient (20%) showed subtotal dissolution at the 4 weeks follow-up. Clinical evaluation showed significant improvement in VAS and Constant scores in 91.7% of patients of Group 1 and in 83.3% of Group 2 ($p<=0.05$). No major complications were reported in both groups.

CONCLUSION

The use of SHMP showed superior results in terms of imagingfindings and clinical improvement compared to the treatment with simple saline

CLINICAL RELEVANCE/APPLICATION

With its chemical action of calcium chelation and dissolution, besides the mechanical action, percutaneous lavage with SHMP is an effective procedure, suitable for different types of calcifications, providing a safe, valid and cost-effective alternative treatment management for calcific tendinitis

SSM14-02 Effect of Compression Stockings on the Development of Delayed-Onset Muscle Soreness: A Quantitative Assessment with 3T MRI, Contrast-Enhanced Ultrasound (CEUS) and Acoustic Radiation Force Impulse (ARFI) Elastography

Wednesday, Nov. 29 3:10PM - 3:20PM Room: E353C

Participants
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Thilo Hotfiel, Erlangen, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To investigate the influence of commercially available sport compression garments on changes in muscle perfusion, muscle stiffness and the development of exercise induced intramuscular edema in the context of DOMS.

METHOD AND MATERIALS

DOMS was induced in fifteen healthy participants. They had to perform a standardized eccentric exercise of the calf muscles. After exercise a conventional sports compression sock (class I, 18-21 mmHg) was placed accordingly manufacturer's instructions at one randomized calf for 60h. MRI (normalized T2 signal intensity and T2-time), CEUS (Peak enhancement (PE) and Wash-in Area Under Curve (WIAUC)) and ARFI (shear wave velocities (SWV)) of the gastrocnemius muscle (GM), as well as creatine kinase activity, extension range of the ankle joint, calf circumference and muscle soreness were assessed at baseline and 60 h after exercise at both calves.

RESULTS

After exercise the normalized T2 signal intensity (1.0±0.30 vs. 1.94±1.05, p=0.008), the T2-time (37.52±9.67 vs. 55.64±12.72 ms, p=0.015) was significantly higher in the GM in the compressed calf; but no change for WIAUC (4322±521 vs. 11730±3536, p=0.88), PE (474±54 vs. 1185±345, p=0.51) and ARFI SWV (2.16±0.31 vs. 2.13±0.32, p=0.60) were observed. In the non-compressed calf all assessed parameters changed significantly: T2: 1.0±0.16 vs. 2.20±1.16, p=0.001; T2-time: 37.75±9.28 vs. 55.67±14.78 ms, p=0.005, WIAUC: 2461±660 vs. 5297±743, p=0.01, PE: 328±45 vs. 753±31, p=0.005, ARFI SWV: 2.2±0.26 vs. 1.78±0.24m/s, p=0.008. No significant difference was observed in normalized T2 signal intensity (p=0.397), T2-time value (p=0.953), WIAUC (p=0.93) and PE (p=0.730) in the GM comparing the compressed and non-compressed lower leg after exercise. Only ARFI SWV values in the same comparison revealed a statistically significant difference (p=0.001).

CONCLUSION

Our results indicate that wearing conventional sports compression socks after inducing DOMS may shorten the normalization of muscle stiffness, but have no significant effect on the degree of intramuscular edema or perfusion of the MGM. Furthermore, no effects on occurring muscle soreness or reduced range of motion were noticed.

CLINICAL RELEVANCE/APPLICATION

Muscle injuries are common sports injuries. Delayed onset muscle soreness (DOMS), an entity of ultrastructural muscle injury is one of the most common reasons for impaired muscle performance in professional and recreational athletes.

SSM14-03 Repeated Ultrasound-Guided Core Needle Biopsy of Musculoskeletal Lesions: Clinical Utility According to the Types of the Lesions

Wednesday, Nov. 29 3:20PM - 3:30PM Room: E353C

Participants
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Myung Jin Shin, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the clinical utility of repeated ultrasound-guided core needle biopsy(US-CNB) of musculoskeletal lesions according to the types of the lesions.

METHOD AND MATERIALS

We retrospectively reviewed 1996 consecutive US-CNBs performed for bone or soft-tissue lesions in 1914 patients during 10 years at a single institution. Repeated biopsy cases for the same lesion were enrolled in this study. The reasons for repeat biopsies were nondiagnostic results, different from clinical expectations, or negative culture results. The reference standard was culture result for infection and pathological diagnosis at excisional biopsy for others. Concordance rate of initial and repeat biopsies were compared according to the types of the lesions by tumors, infection, or others. McNemar's test were used for their statistical significance ($p < .05$).

RESULTS

Of the 30 cases of repeat biopsy, final pathologies were bone and soft tissue tumor, 18(60%); infection, 8(27%); and others, 4(13%). Among the 18 tumors, 16(89%) cases were soft tissue tumors and 14(78%) were malignancy. The overall concordance rate of initial biopsy was 23%(7/30) and that for repeat biopsy was 60%(18/30), which revealed significantly higher concordance for repeated biopsy (p=0.001). The initial and repeated concordance rates of bone and soft tissue tumor were 22%(4/18) and 72%(13/18), respectively. Repeated US-CNB for bone and soft tissue tumor increased diagnostic rate significantly compared to the initial biopsy (p=0.008). The pathogen concordance rates between the initial and repeated US-CNB for infectious cases were 0%(0/8) and 13%(1/8), which showed no significant difference (p=1.000).

CONCLUSION

Repeated US-CNB of musculoskeletal bone and soft tissue tumors can be useful for accurate diagnoses. However, in cases of

Repeated US-CNB of musculoskeletal bone and soft tissue tumors can be useful for accurate diagnoses. However, in cases of infection, repeated US-CNB may have limited clinical utility for pathogen determination.

CLINICAL RELEVANCE/APPLICATION

Repeated US-CNB can be useful for accurate diagnoses of musculoskeletal bone and soft tissue lesions. However, we should consider the types of the lesions. Although repeated CNB increased diagnostic rate for bone and soft tissue tumors, but did not increase the pathogen determination for infection.

SSM14-04 Adhesive Capsulitis of the Shoulder: Evaluation with US-Arthrography Using a Sonographic Contrast Agent

Wednesday, Nov. 29 3:30PM - 3:40PM Room: E353C

Participants
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CONCLUSION

Consequently, US-arthrography was more effective method than US for assessment of AC. Filling defects of joint cavity and synovitis-like abnormality in the joint are characteristic US-arthrography findings for diagnosing AC.

Background

Adhesive capsulitis (AC) is a painful and disabling disorder, which caused restricted motion and chronic pain of shoulder. Intracavitary contrast-enhanced ultrasound has recently applied to assess obstructive bile duct diseases, tubal patency, vesicoureteric reflux and so on.

Evaluation

The aim of this study was to detect the value of US-arthrography by injecting the contrast agent SonoVue into glenohumeral joint compared with US in diagnosing AC.

Discussion

US and US-arthrography images of 45 patients with AC were compared with that of 45 control subjects without AC with MRI as a gold standard.Patients with AC had a significantly thickened CHL (3.1 mm) and inferior capsule (3.5 mm) on US, and a decreased volume of axillary recess (1.14 ml) on US-arthrography compared with the control subjects. Filling defect (91.1%) and synovitis-like abnormality (75.6%) in the joint on US-arthrography were more sensitive than that of rotator interval abnormality (71.1%), thickened CHL more than 3 mm (64.4%), thickened inferior capsule more than 3.5 mm (66.7%) on US respectively for diagnosis of AC.

SSM14-05 Contrast-Enhanced Ultrasound (CEUS) as a New Method in Diagnostic Imaging of Muscle Injuries: Systematic Comparison of Conventional Ultrasound, CEUS and Findings in MRI

Wednesday, Nov. 29 3:40PM - 3:50PM Room: E353C

Participants
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PURPOSE

To emphasize the diagnostic value of contrast-enhanced ultrasound (CEUS) in imaging of muscle injuries with different degrees of severity by comparing findings to the established imaging modalities as conventional ultrasound and magnet resonance imaging (MRI).

METHOD AND MATERIALS

A total of 15 patients were examined after indirect muscular injuries on the lower extremity. Within 24 - 48 hours after injury, a conventional sonography and a CEUS were performed. Direct after the sonography, an MRI was performed as a 'gold standard' in order to graduate the lesion and to determine the spatial extent of the lesion as a reference variable. The classification was carried out according to the modified, four-stage Peetron classification described by Ekstrand et al..

RESULTS

All 15 injuries were identified on MRI and CEUS, whereas 10 injuries showed abnormalities in conventional ultrasound. The determination and measurement revealed significant differences between conventional ultrasound and CEUS depending on the injuries' severity. CEUS revealed an impairment of microcirculation in grade I lesions (corresponding to intramuscular edema observed in MRI), which were not detectable in conventional ultrasound.

CONCLUSION

Our results indicate that performing CEUS seems to be a sensitive additional diagnostic modality in the assessment of muscle injuries in the acute phase after injury. Our results provide advantages of CEUS in imaging of low grade lesions compared to

conventional ultrasound, as they show its superiority in the identifiability of intramuscular edema.

CLINICAL RELEVANCE/APPLICATION

Muscle injuries are frequently observed during recreational and professional sports and have been reported as one of the most common sports injuries. Diagnostic imaging is essential to provide a correct assessment of the injury's severity. So far MRI has shown its superiority over ultrasound examination and has been reported as the preferred modality providing detailed image analysis and characterization of an intramuscular lesion. In clinical practice, however, MRI is often reserved for high-level athletes or serious injuries in which a pronounced structural damage is expected. In conventional ultrasound diagnostic of low grade lesions (ultrastructural lesions and muscle strains), the concerned muscle tissue often appears normal. In this context CEUS may be a new investigative tool in the diagnostic imaging of low grade muscle lesions.

SSM14-06 Quantitative Assessment of Skin Stiffness in Localized Scleroderma Using Ultrasound Shear-Wave Elastography

Wednesday, Nov. 29 3:50PM - 4:00PM Room: E353C

Participants
Liyun Wang, Chengdu, China (*Presenter*) Nothing to Disclose
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PURPOSE

The purpose of this study was to evaluate the usefulness of ultrasound shear-wave elastography (US-SWE) in characterization of localized scleroderma (LS), as well as in the disease staging.

METHOD AND MATERIALS

21 patients with 37 LS lesions were enrolled in this study. The pathological stage (edema, sclerosis or atrophy) of the lesions was characterized by pathological examination. The skin elastic modulus (E-values, including Emean, Emin, Emax and Esd) and thickness (h) was evaluated both in LS lesions and site-matched unaffected skins (normal controls) using US-SWE. The relative difference (ERD) of E-values was calculated between each pair of lesion and its normal control for comparison among different pathological stages.

RESULTS

Of the 37 LS lesions, 2 were in edema, 22 in sclerosis and 13 in atrophy. US-SWE results showed a significant increase of skin elastic modulus and thickness in all lesions ($p<0.001$ in sclerosis and $p< 0.05$ in atrophy) compared to the normal controls. The measured skin elastic modulus and thickness were greater in sclerosis than in atrophy. However, once normalized by skin thickness, the atrophic lesions, which were on average thinner, appeared significantly stiffer than those of the sclerosis (normalized ERD: an increase of 316.3% in atrophy vs. 50.6% in sclerosis compared to the controls, $p = 0.007$).

CONCLUSION

These findings suggest that US-SWE allows to quantitatively evaluate the skin stiffness of LS lesions in different stages; however, the E-values directly provided by US-SWE system alone do not distinguish between the stages, and the normalization by skin thickness is necessary. This non- invasive, real-time imaging technique is an ideal tool for assessing and monitoring LS disease severity and progression.

CLINICAL RELEVANCE/APPLICATION

Ultrasound shear-wave elastography can measure skin stiffness in LS patients which can be used to assesse and monitor LS disease severity and progression.

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103rd Scientific Assembly and Annual Meeting
November 26 to December 1
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SSM15

Nuclear Medicine (Head and Neck Imaging)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S505AB

CT HN MR NR NM

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM15-01 Integrated 11C-MET PET/MRI for Detection of Recurrent Glioma

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S505AB

Participants
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PURPOSE

The objective of this study was to evaluate hybrid 11C-MET PET/MRI for detection of recurrent glioma.

METHOD AND MATERIALS

Fifty consecutive patients with histopathological proven glioma (9 Low Grade Glioma (LGG), 33 High Grade Glioma (HGG), 8 Oligodendroglioma (OGG)) were prospectively enrolled for a hybrid 11C-MET PET/MRI to differentiate recurrent glioma from treatment induced changes. Sole MRI data were analyzed based on RANO. Sole PET data and in a second session hybrid 11C-PET/MRI data were assessed for metabolic respectively metabolic and morphologic glioma recurrence. Reference standard was either histopathological report (n = 22) or follow-up imaging (n=28), whereas only patients of at least 6 months with follow up imaging were included. Based on the reference standard 35 patients were classified with recurrent glioma, whereas 15 patients with treatment induced changes.

RESULTS

Hybrid 11C-MET PET/MRI was performed in 50 patients for differentiation between recurrent glioma and treatment induced changes.Sensitivity, specificity, positive predictive value and negative predictive was calculated 86,11%, 71,43%, 88,57%, 66,67 for 11C-MET PET alone; 96,77%, 73,68%, 85,71%, 93,33% for MRI alone and 97,14%, 93,33%, 97,14%, 93,33% for hybrid 11C-PET/MRI, respectively. In all 50 patients diagnoses based on the reference standard were correct in 82% for 11C-MET PET, 88% for MRI alone and 96% for hybrid 11C-PET/MRI. A significant difference was found among hybrid 11C-MET PET/MRI and 11C-MET PET (p=0,016), whereas no significant difference was found among hybrid 11C-PET/MRI and MRI alone or MRI alone and 11C-MET PET alone. Furthermore, significant ($P < 0.05$) higher scores were found for diagnostic confidence when comparing 11C-MET PET/MRI (4,26 ± 0,777) to 11C-MET PET alone (3,44 ± 0.705) or to MRI alone (3,56 ± 0.733).

CONCLUSION

Hybrid 11C-MET PET/MRI offers metabolic and morphological information for the assessment of glioma recurrence. The hybrid imaging concept increases accuracy and showed significant higher scores for diagnostic confidence when compared to MRI or PET.

CLINICAL RELEVANCE/APPLICATION

Hybrid 11C-MET PET/MRI might have the potential to strengthen RANO classification by adding the metabolic information. This should be evaluated in larger study cohorts.

SSM15-02 Does 18F-FDG PET/MR Increase the Diagnostic Performance for Recurrence Diagnostics in Comparison to MRI in Patients Suffering From Adenoid Cystic Carcinoma of the Head and Neck?

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S505AB

Participants
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Cornelius Deuschl, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose
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Verena Ruhlmann, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To compare the diagnostic performance between 18F-fluorodeoxyglucose positron emission tomography / magnetic resonance (18F-FDG PET/MR) and MR imaging for the detection of recurrent adenoid cystic carcinoma (ACC) of the head and neck and locoregional metastases.

METHOD AND MATERIALS

In this retrospective analysis, a total of 31 dedicated 18F-FDG PET/MR examinations of the head and neck performed for recurrence diagnostics and locoregional metastases detection in patients after primary therapy of ACC were included (12 patients, mean age 59 years). In separate sessions, MRI and 18F-FDG PET/MR images were analyzed by two individual readers. Tumor recurrence or metastatic disease was confirmed by clinical and radiological follow-up examinations. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated on a per lesion basis and diagnostic accuracy between both modalities was compared using McNemar's test. $p<0.05$ was considered as statistically significant.

RESULTS

Tumor recurrence and / or locoregional metastases were detected in 20 examinations. 18F-FDG PET/MR correctly identified all 20 suspicious examinations, while MRI detected 19 of 20 examinations. On a per lesion basis, sensitivity, specificity, PPV and NPV were 77%, 94%, 95% and 73% for MRI and 96%, 84%, 90% and 93% for 18F-FDG PET/MR, respectively. On a per lesion basis, the diagnostic accuracy of 18F-FDG PET/MR (91%) was significantly higher in comparison to MRI (84%, $p<0.05$).

CONCLUSION

In patients suffering from ACC of the head and neck, 18F-FDG PET/MR is superior to MRI in detection tumor recurrence and locoregional metastases. Especially the superior NPV of 18F-FDG PET/MR is advantageous in regular follow-up examinations after primary tumor treatment in patients suffering from ACC.

CLINICAL RELEVANCE/APPLICATION

In comparison to MRI, 18F-FDG PET/MR provides a superior diagnostic performance in follow-up examinations after primary treatment of adenoid cystic carcinoma of the head and neck.

SSM15-03 4'-[Methyl-11C]-Thiothymidine PET/CT for Early Assessment of Disease Control Of Chemoradiotherapy for Head and Neck Squamous Cell Carcinoma: Comparison with FDG PET/CT

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S505AB

Participants
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Takashi Norikane, Kita-gun, Japan (*Abstract Co-Author*) Nothing to Disclose
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Yoshihiro Nishiyama, MD, Kagawa, Japan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

A new radiopharmaceutical, 4'-[methyl-11C]-thiothymidine (4DST), has been developed as an in vivo cell proliferation marker based on the DNA incorporation method. The purpose of this study was to evaluate the usefulness of 4DST PET/CT for early assessment of disease control of chemoradiotherapy for head and neck squamous cell carcinoma (HNSCC), in comparison with 2-deoxy-2-18F-fluoro-D-glucose (FDG) PET/CT.

METHOD AND MATERIALS

A total of 28 patients with HNSCC underwent 4DST and FDG PET/CT studies before, during, and after therapy. Uptake of 4DST and FDG was examined visually and semiquantitatively using standardized uptake value (SUV) for before, during and after therapy (SUVbefore, SUVduring and SUVafter, respectively). Percent change (during) was calculated from SUVbefore and SUVduring and percent change (after) was calculated from SUVbefore and SUVafter. Based on histopathological verification or radiologic follow-up, patients were divided into relapse-free and relapse groups. Relapse-free group was defined as those having no local recurrence or distant metastasis.

RESULTS

In all 28 patients, focally increased 4DST and FDG uptake in primary lesion was visible. On both 4DST PET/CT scans during and after therapy, 23 patients showed no increased uptake in primary lesion. On FDG PET/CT scans during and after therapy, 16 and 18 patients showed no increased uptake in primary lesion, respectively. Twenty-two patients were found to be relapse-free group and 6 to be relapse group. SUVduring and SUVafter values from 4DST PET/CT in relapse-free group were significantly lower than those in relapse group ($p<0.001$, respectively). The percent change (during) and percent change (after) values from 4DST PET/CT in relapse-free group were significantly higher than those in relapse group ($p<0.001$, respectively). Using FDG PET/CT, SUVduring, SUVafter, percent change (during) and percent change (after) were not significant differences between relapse-free and relapse groups.

CONCLUSION

The results of this preliminary study suggest that, compared with FDG PET/CT, 4DST PET/CT may be useful for early assessment of disease control of chemoradiotherapy in patients with HNSCC.

CLINICAL RELEVANCE/APPLICATION

4DST PET/CT may be useful for early assessment of disease control of chemoradiotherapy in patients with HNSCC.

SSM15-04 The Value 18F-FDG PET/CT in Early Stage Squamous Cell Carcinoma of the Oral Cavity

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S505AB

Participants
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PURPOSE

The purpose of this study is to evaluate the value of 18-F fluorodeoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT) for staging of early stage squamous cell carcinoma (SCC) of the oral cavity. Nodal staging on 18F-FDG PET/CT was compared with magnetic resonance imaging (MRI) of the neck and correlated with pathological staging on neck dissections.

METHOD AND MATERIALS

A retrospective review of all patients with clinically T1 and T2, biopsy-proven, squamous cell carcinoma of the oral cavity, and a clinically node-negative neck, between 2012 and 2017 was carried out. All patients that underwent both 18F-FDG PET/CT and MRI neck prior to surgical resection were included. The N and M stages on PET/CT were recorded, according to the AJCC/UICC TNM staging system, along with any incidental findings requiring further investigation. N stage on MRI was also recorded. Pathology reports were reviewed for pathological staging of the primary tumour and nodal status.

RESULTS

Sixty-four patients have been reviewed to date. Fifty-seven (89%) patients proceeded to neck dissection. Of these patients, 47 (82.5%) were histologically-proven node negative and 10 (17.5%) had histologically-proven nodal metastases. Of those patients with nodal metastases, 4 patients were staged N1 on PET/CT and 6 were staged N0. There were 2 patients with nodal metastases staged N1 on PET/CT but N0 on MRI. Of the node negative patients, 44 were staged N0 on PET/CT and 3 were staged N1. This yields a sensitivity of 40%, specificity of 93.6%, positive predictive value of 57.1% and negative predictive value of 88%. All patients were staged as M0 on PET/CT. Incidental findings requiring further clinical and radiological investigation were detected on PET/CT in 23 (35.9%).

CONCLUSION

Occult cervical nodal metastases are relatively infrequent in early stage SCC of the oral cavity with a clinically node negative neck. The relatively high specificity and negative predictive value of PET/CT in this study is due to the low prevalence of nodal metastases in this patient cohort. This study demonstrates that PET/CT is of limited value in conjunction with MRI for the detection of nodal metastases in these patients.

CLINICAL RELEVANCE/APPLICATION

The clinically node negative neck in early stage SCC of the oral cavity poses a potential treatment dilemma. PET/CT is of limited value in the detection of nodal metastases in these patients.

SSM15-05 Clinical Value of Three-Dimensional SPECT/CT Imaging For Assessment of Jaw Bone Invasion in Oral Cancers

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S505AB

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PURPOSE

Imaging diagnosis of jaw bone invasion in oral cancers is still challenging due to dental artifacts as well as difficulty in detecting morphological change of early invasion. We have recently developed three-dimensional (3D) single-photon emission computed

tomography-computed tomography (SPECT/CT) imaging. We aimed to investigate the diagnostic performance of 3D SPECT/CT imaging for jaw bone invasion in comparison with other imaging modalities.

METHOD AND MATERIALS

Preoperative 3D SPECT/CT, contrast-enhanced CT (ceCT), and MRI images in 14 oral cancer patients were retrospectively evaluated by an oral surgeon. Each of the 3 image sets was independently reviewed with the knowledge of the tumor locations as to the likelihood of jaw bone invasion. When reviewing 3D SPECT/CT images, 3D volume-rendered SPECT/CT images with and without clip-plane editing were generated in order to grasp 2D and 3D bone anatomy and metabolism. The likelihood was classified using a 5-point diagnostic confidence scale. A jaw bone without cancer invasion that was scored as 1, 2 or 3 was considered true negative. A jaw bone with cancer invasion that was scored as 4 or 5 was considered true positive. Imaging results were compared with postsurgical results.

RESULTS

Seven of the 14 patients had jaw bone invasion of cancer cells and the other 7 did not. The sensitivity, specificity, positive and negative predictive values in the diagnosis of jaw bone invasion were 100% (7/7), 71% (5/7), 78% (7/9) and 100% (5/5) in 3D SPECT/CT, 43% (3/7), 86% (6/7), 75% (3/4), 60% (6/10) in ceCT, and 57% (4/7), 86% (6/7), 80% (4/5) and 67% (6/9) in MRI, respectively. Receiver operating characteristic analysis showed that 3D SPECT, ceCT and MRI had an area under the curve of 0.837, 0.786 and 0.704, respectively (not statistically different). Two cases with false-positive findings in 3D SPECT/CT had destruction of both periosteal and alveolar bones with severe inflammatory cell infiltration around the tumor sites.

CONCLUSION

3D SPECT/CT may be more sensitive than ceCT or MRI in the detection of jaw bone invasion.

CLINICAL RELEVANCE/APPLICATION

3D SPECT/CT appears more sensitive than ceCT or MRI in detecting jaw bone invasion in oral cancers and may be useful when jaw bone invasion is unclear with ceCT or MRI.

SSM15-06 The Usefulness of Initial Treatment Effects Based On PERSIST Criteria in Predicting the Three Years Disease Free Survival of Head and Neck Cancer

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S505AB

Participants
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PURPOSE

The study was done to evaluate the usefulness of the initial treatment effects based on PERSIST criteria in predicting the disease free survival (DFS) 3 years after the initial therapy of head and neck cancer (HNC).

METHOD AND MATERIALS

We analyzed retrospectively fifty-one cases of HNC, 35 male and 16 female, 18 hypo-pharynx cancer, 9 gingival cancer, 9 tongue cancer, 7 laryngeal cancer, 4 maximal cancer and 4 oropharynx cancer. All cases were performed FDG-PET/CT on both before and after the initial therapy. Chemo-radiotherapies were done in 35 patients and radiotherapies were done in 16 patients. We divided all patients into 2 groups, the responders (CMR+PMR) and the non-responders (SMD+PMD), based on the result of RECIST criteria. Then we compared the diagnostic ability of predicting DFS 3 years after the initial therapy among the result of initial therapeutic effect by PERCIST criteria and three kinds of FDG uptake parameters. The FDG uptake parameters were SUL max (< 16.0) ,SUL peak (< 12.0) and TLG(< 180g) obtained before the initial therapy respectively.

RESULTS

Among 36 responders, 25 cases (69.0%) reached 3 years DFS. In contrast, only 5 of 15 cases non-responders (33.0%) could reach 3 years DFS. The diagnostic accuracy of initial treatment effects based on PERSIST criteria for predicting 3 years DFS was 68.6%. Regarding FDG uptake indices before the initial therapy, TLG (<180g) was the most powerful predictor among three kinds of indexes (TLG 68.6%, SUL max 51.0%, SUL peak 52.9 %, in accuracy).

CONCLUSION

We could predict 3 years DFS with high probability based on the result of PERCIST criteria after the initial therapy in patients of HNC. Similarly, TLG (<180g) before the initial therapy was also good predictor of 3 years DFS.

CLINICAL RELEVANCE/APPLICATION

The result of the initial therapy based on PERCIST is useful not only for diagnosing therapeutic effect but also for predicting DFS 3 years after the initial therapy in HNC patients.

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SSM16

Neuroradiology (Gadolinium Deposition)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N226

MR NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM16-01 Assessment of the Neurologic Effects of Intracranial Gadolinium Deposition Using a Large Population Based Cohort

Wednesday, Nov. 29 3:00PM - 3:10PM Room: N226

Participants
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PURPOSE

The neurotoxic potential of intracranial gadolinium (Gd) deposition following intravenous administration of gadolinium based contrast agents (GBCAs) is undefined. In the current study, we used the world's largest prospective population-based cohort on aging to study the effects of Gd exposure on neurologic and neurocognitive function.

METHOD AND MATERIALS

The Mayo Clinic Study of Aging (MCSA) cohort was enumerated from the Rochester Epidemiology Project in 2004 to study the incidence and natural history of cognitive impairment and dementia. All participants underwent extensive longitudinal clinical (neurologic evaluation, neuropsychological testing) assessment at baseline and 15-month follow-up intervals. Neurologic and neurocognitive scores were compared using standard multivariate methods between MCSA patients with no history of prior Gd exposure and those who underwent prior Gd-enhanced MRI. Progression from normal cognitive status to mild-cognitive impairment and dementia was assessed using multistate Markov model analysis.

RESULTS

Among 4261 cognitively normal study participants aged 50-90 (mean age (SD): 71.9 yrs (10.7), mean study participation (SD): 3.7 yrs (3.0)), 1092 (25.6%) received one or more GBCA doses (median: 2 doses, range: 1-28 doses) unrelated to their participation in the MCSA. Median time since first Gd exposure was 5.6 years (IQR=2.2-9.3 years). After adjusting for age, sex, education level, baseline neurocognitive performance, Charlson comorbidity index, and ApoE4 status, GBCA exposure was not a significant predictor of cognitive decline (changes in clinical dementia rating (p=.48), Blessed dementia scale (p=.68), or mental status exam score (p=.55)), diminished neuropsychological performance (p=.13), or diminished motor performance (Unified Parkinson's Disease Rating Scale (p=.43)). No dose-related effects were observed among these metrics (p=.89-.20). Finally, Gd exposure was not an independent risk factor in the rate of cognitive decline from normal cognitive status to dementia in this cohort (p=.91).

CONCLUSION

GBCA administration was not associated with worse overall neurologic or neurocognitive performance nor does it significantly affect the natural progression of cognitive decline in a large population-based cohort.

CLINICAL RELEVANCE/APPLICATION

Despite evidence of Gd accumulation following intravenous GBCA administration, Gd exposure is not associated with adverse neurologic outcomes.

SSM16-02 Differences in Gadolinium Retention after Repeated Injections of Macrocyclic MR Contrast Agents to

Rats

Wednesday, Nov. 29 3:10PM - 3:20PM Room: N226

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PURPOSE

To investigate whether significant differences exist among macrocyclic MR contrast agents with respect to their retention in cerebellum, brain, kidneys and other organs.

METHOD AND MATERIALS

Gadobutrol (Gadovist®; Bayer), gadoterate meglumine (Gd-DOTA, Dotarem®; Guerbet), gadoteridol (ProHance®; Bracco) or Saline solution (0.9% w/v NaCl) were administered at 0.6 mmol/kg (1.2 mL/kg for saline) four times a week for five weeks to healthy male Wistar Han rats, randomly assigned to each of the four groups (n=15/group). After the end of the treatment, a recovery period of 4 weeks (28 d) was allowed before sacrifice. Organs (blood, cerebrum, cerebellum, liver, femur, kidneys and skin) were then collected for ICP-MS determination of gadolinium. Based on available amounts of samples, the LOQ (Limit of Quantitation) for Gd was 0.1 nmol/mL for blood, 0.1 nmol/g for cerebrum/cerebellum, 0.5 nmol/g for femur, 1 nmol/g for liver and skin. 1.7 nmol/g for kidneys. Statistical analysis was carried out by an independent expert.

RESULTS

Both in cerebellum and in cerebrum ProHance resulted in significantly ($p < 0.001$) lower levels of gadolinium compared both to Dotarem and to Gadovist. Also in the kidneys ProHance showed a residue that was significantly lower than both Dotarem (6 times higher; $p < 0.01$) and Gadovist (8 times higher; $p < 0.001$). In the femur, the differences were less pronounced, with only gadoterate meglumine showing a lower accumulation than gadobutrol ($p < 0.001$) and gadoteridol ($p < 0.05$). Gd concentration in blood, liver and skin samples was < LOQ.

CONCLUSION

After repeated injections of the 3 macrocyclic GBCAs and a 4-week off-dose period, ProHance resulted in significantly lower gadolinium concentrations than either Dotarem or Gadovist in cerebellum, cerebrum and kidneys. The observed differences, in the absence of dechelation, point to differences in wash-out rates, with gadoteridol being the GBCA that is most efficiently removed from both CNS and renal tissues.

CLINICAL RELEVANCE/APPLICATION

This non-clinical study shows that also macrocyclic MR contrast agents differ in the extent of retention in CNS and renal tissues, with ProHance giving less retention than Gadovist or Dotarem.

SSM16-03 Absence of Toxicity in Extended Duration Study of Gadolinium in Rodent Brains after Repeat Dosing of Gadodiamide: Investigation of Concentration, Location and Cell Ultrastructure

Wednesday, Nov. 29 3:20PM - 3:30PM Room: N226

Participants
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PURPOSE

Recent studies report low levels of gadolinium based contrast agents in the brain following repeat exposure. The purpose of this study was to evaluate the levels of Omniscan in the rat brain up to one year post-dosing, to evaluate the location of retained gadolinium, and to determine if there were any neurohistopathological sequelae.

METHOD AND MATERIALS

This study reports on a 50-week experimental endpoint from a previously published study (Smith et al. Radiology, 282:3, March 2017) together with additional analyses at the 1, 20 and 50 week timepoints. Gadolinium concentrations were quantified in blood and brains of rats 50 weeks after the cessation of dosing (cumulative dose 12 mmol/kg over 5 weeks) using inductively coupled plasma mass spectrometry (ICP-MS). Brain sections at standard toxicological levels were evaluated by standard toxicological

assessment. A portion of the Deep Cerebellar Nucleus (DCN) was reserved and processed for transmission electron microscopic (TEM) cell ultrastructure analysis and TEM with electron dispersive spectroscopy (TEM-EDS).

RESULTS

Gadolinium levels at 50 weeks were comparable to those observed at 20 weeks. Toxicologic histopathology analysis revealed no findings, and cell ultrastructural TEM analysis similarly revealed no findings, indicating that this extended period of gadolinium exposure for up to 1 year did not result in any tissue injury. A TEM-EDS analysis of gadolinium localization in the DCN showed approximately 100 nanometer foci located in the basal lamina, abluminal to the endothelium.

CONCLUSION

We conclude that whilst a small portion of gadolinium in the brain after repeat doses of GBCA is subject to long term retention (approximately 1/1,000,000 of the injected dose), this does not result in any observable tissue injury. We further propose that this gadolinium is in perivascular foci, and we have not found foci in the brain parenchyma.

CLINICAL RELEVANCE/APPLICATION

These observations are consistent with clinical observations of brain Gd in the human brain but without histopathological changes or a corresponding clinical syndrome.

SSM16-04 Long Term Deposition with Slow Clearance of Gadolinium in Cerebellum After Repeated Injections of Gadodiamide as compared to Gadoterate Meglumine in Rats

Wednesday, Nov. 29 3:30PM - 3:40PM Room: N226

Participants
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PURPOSE

The objective of this study is to compare the long-term kinetics of Gd deposition in the cerebellum for gadodiamide (Omniscan®, linear contrast agent) and gadoterate meglumine (Dotarem®, macrocyclic contrast agent).

METHOD AND MATERIALS

Injection protocol: N=120 healthy rats received 5 intravenous injections of 2.4 mmol/kg of gadodiamide or gadoterate meglumine (N=60/agent) over a period of 5 weeks (1 injection per week) according to a published protocol (Robert 2016). Rats were divided in 6 groups with 0, 1, 2, 3, 4 and 5 months of washout period (N=10/agent, groups M0, M1, M2, M3, M4 and M5 respectively). Gd dosing: At each delay, animals were sacrificed. Blood and cerebellum were sampled and total Gd concentrations were dosed by the ICP-MS technic. Pharmaco-kinetics analysis: tissue Gd elimination kinetics in the cerebellum were fitted to estimate the tissue elimination half-lives in days along the 5 months of washout.

RESULTS

At all time-points, a significantly higher concentration of total Gd was found in cerebellum for gadodiamide groups as compared to gadoterate groups. Five months after the last injection, 30-fold more Gd was measured in the cerebellum in the gadodiamide group (2.29±0.30nmol/g) versus gadoterate (0.075±0.037nmol/g, $p<0.0001$). At this time-point, no remaining Gd was detected in the blood for both products. For gadodiamide, mean half-life of elimination (T1/2) of Gd accumulated in the cerebellum was 410 days. For comparison, more than 87% of Gd was cleared from the cerebellum with a T1/2 of 15 days for gadoterate meglumine.

CONCLUSION

A 30-fold higher total Gd concentration in the cerebellum was found 5 months after gadodiamide treatment as compared to gadoterate. Elimination of Gd from the cerebellum was 28-fold slower after injection of gadodiamide as compared to gadoterate meglumine. Recent studies have shown that a large amount of Gd is present under dechelated form one month after repeated injections of linear Gd contrast agents (Frenzel 2017) in contrary to macrocyclic Gd contrast agents which are excreted in chelated form. Such speciation analysis are ongoing on these long term data.

CLINICAL RELEVANCE/APPLICATION

After injection of linear Gd-based contrast agent gadodiamide, long term total Gd concentration in the cerebellum is 30-fold higher and elimination rate is 28-fold slower as compared to the macrocyclic gadoterate meglumine.

SSM16-05 Penetration and Distribution of Gadolinium-Based Contrast Agents into Cerebrospinal Fluid in Humans

Wednesday, Nov. 29 3:40PM - 3:50PM Room: N226

Participants
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PURPOSE

Signal hyperintensity on unenhanced T1-weighted magnetic resonance (MR) images correlating with gadolinium deposition has been reported after multiple administrations of gadolinium-based contrast agents (GBCAs). This increase seems to be primarily associated with the repeated use of linear GBCAs. Recent studies on healthy rats have furthermore demonstrated that the blood-cerebrospinal fluid (CSF) barrier is permeable to not only linear but also macrocylcic GBCAs. The aim of our clinical study was to evaluate whether gadolinium (Gd) can be detected in CSF, to the best of our knowledge, for the first time in humans.

METHOD AND MATERIALS

This study was approved by the local Ethics committee with patient's consent authorizing use of tissue samples in research studies. For inclusion, all patients with a lumbar puncture between January and August 2016 were screened for at least one previous MR examination with GBCA administration (gadoterate meglumine at a dose of 0.1 mmol/kg bodyweight) within a time frame of 60 days prior to CSF extraction. A total of 39 consecutive samples fullfilling these criteria were identified. These patients were enrolled and their CSF was analyzed for the presence of Gd. The control group consisted of 10 patients without any prior intravenous GBCA administration according to medical files. Gd measurements in the CSF were performed using inductively coupled plasma mass spectrometry by monitoring the response of the 158Gd isotope.

RESULTS

In all cases with prior GBCA administration, Gd could be detected in the CSF. Gd concentration in the CSF showed a steady increase over 6 hours following the intravenous injection of the contrast agent. A significant decrease of Gd concentration compared to the peak values could be detected 24 hours after injection. Less amounts but still measurable concentrations of Gd could be detected several days/weeks after contrast enhanced MR examination. Control groups were all negative for Gd presence as expected.

CONCLUSION

Gadoterate meglumine, a macrocyclic GBCA, crosses the blood-brain barrier in humans and penetrates the CSF, in accordance with previous preclinical studies on healthy rats. Traces of GBCA can be detected in the CSF days/weeks after iv administration.

CLINICAL RELEVANCE/APPLICATION

It seems that the glio-vascular pathway via the CSF is a potential entrance way for GBCA into the brain.

SSM16-06 Cerebrospinal Fluid (CSF) Gadolinium Accumulation after Intravenous Gadobutrol-Enhanced MRI

Wednesday, Nov. 29 3:50PM - 4:00PM Room: N226

Awards
Student Travel Stipend Award

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PURPOSE

Recent studies in the setting of an intact blood brain barrier (BBB) have demonstrated intracranial gadolinium deposition following MRI with gadolinium-based contrast agents (GBCAs). While the mechanism of gadolinium distribution from bloodstream to neuronal tissue remains unclear, a proposed mechanism is through the blood-cerebrospinal fluid (CSF) barrier. This study evaluates gadolinium accumulation in the CSF after intravenous Gadobutrol administration.

METHOD AND MATERIALS

Patients who underwent a Gadobutrol-enhanced MRI and subsequent lumbar puncture (LP) within a period of 30 days (Gadobutrol group) were included versus a control group who had an LP without prior history of receiving gadolinium-enhanced MRI. Serum samples were also obtained following MRI exam. Gadolinium in CSF and serum samples was quantified using inductively coupled plasma mass spectrometry. Intact BBB was defined as total CSF protein less than or equal to 35 mg/dL. The relationship between gadolinium clearance and patient characteristics (ie. age, gender, CSF protein), and between serum and CSF gadolinium concentration were examined using regression models.

RESULTS

Eighty two (n=82) pediatric and adult patients (68 Gadobutrol, 14 control) were included. Time between Gadobutrol exposure and CSF collection ranged from 1.1 and 594 hours. Gadolinium was detected in the CSF of all Gadobutrol group patients (range 0.2 to 1494 ng/mL); alternatively the median gadolinium concentration in the control group patients was 0 ng/mL (IQR 0 - 0 ng/mL). Pediatric patients (<18 years) and those with an intact BBB had significantly faster clearance of gadolinium compared to adult patients and those with compromised BBB (CSF protein >35 mg/dL) (p=0.046 and <0.001, respectively). Furthermore there was significant correlation between gadolinium concentrations in the serum (range 2.2 - 277.8 ng/mL) and CSF samples (p<.0001).

CONCLUSION

Intravenous administration of Gadobutrol results in gadolinium accumulation within the CSF, even in the setting of normal renal function and no BBB dysfunction. Further research is required to determine the mechanism and clinical significance of gadolinium accumulation in CSF.

CLINICAL RELEVANCE/APPLICATION

Gadolinium accumulates in the CSF following intravenous administration of Gadobutrol in the absence of neurologic pathology and normal renal function, suggesting a route for intracranial deposition.

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SSM17

Neuroradiology (Intracranial Vascular Imaging: Pipe Dream or Reality?)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N227B

MR NR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM17-01 Reduced Intravoxel Incoherent Motion Microvascular Perfusion Predicts Delayed Cerebral Ischemia and Vasospasm After Cerebral Aneurysm Rupture

Wednesday, Nov. 29 3:00PM - 3:10PM Room: N227B

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PURPOSE

Cerebral arterial vasospasm and clinical delayed cerebral ischemia (DCI) following aneurysmal subarachnoid hemorrhage (aSAH) accounts for up to 30% of the morbidity and mortality in these patients. Neurologic examinations, daily transcranial Doppler ultrasound (TCD), and screening CT/CT Angiography/CT Perfusion studies have limited sensitivity and specificity in identifying DCI. Intravoxel incoherent motion (IVIM) MRI extracts microvascular perfusion information from a multi-b value diffusion-weighted sequence. We determined whether decreased IVIM perfusion on brain MRI may identify patients with DCI and cerebral vasospasm.

METHOD AND MATERIALS

We performed a retrospective cohort study of patients with aneurysmal SAH rupture at our neurovascular center. Consecutive patients who underwent a brain MRI after ruptured aneurysm treatment with neurologic deterioration and possible DCI were included. Intravoxel incoherent motion was included in all MRI examinations during the study period. Patient demographic, DCI development, aneurysm and vasospasm treatment, and outcome data were determined by electronic medical record review. Statistical analysis was performed using Excel and SPSS.

RESULTS

16 patients (11 female; 5 male; p=0.9) were included. 10 patients (63%) developed DCI and vasospasm requiring endovascular treatment (DCI+ group) and 6 (37%) did not (DCI- group). DCI+ patients were younger (mean 59 years versus 70 years in the DCI- group; p=0.03); there were no differences in medical co-morbidities between these groups. Presentation Glasgow Coma Scale, Hunt and Hess Scale, and Fisher Grade were also similar between these groups. 20 MRI studies (14 in DCI+ and 6 in DCI-) were performed. All MRIs were performed prior to endovascular vasospasm treatment in DCI+ patients. Whole brain microvascular blood volume on IVIM was significantly reduced in DCI+ patients (mean±sd 0.13±0.02 mm2/s) compared to DCI- patients (0.9±0.03 mm2/s; p=0.03). There was no significant difference in arterial spin labeling or perfusion weighted imaging measures of cerebral perfusion between DCI+ and DCI- patients.

CONCLUSION

Decreased microvascular blood volume on IVIM correlates with DCI development following cerebral aneurysm rupture.

CLINICAL RELEVANCE/APPLICATION

IVIM perfusion may be a useful biomarker for DCI and a triage tool for endovascular vasospasm treatment. Prospective studies should validate this hypothesis.

SSM17-02 Assessment of Steal Phenomenon in MMD Patients with Combination of T-ASL and MRA

Wednesday, Nov. 29 3:10PM - 3:20PM Room: N227B

Participants
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PURPOSE

Steal phenomenon is an independent risk factor for future stroke. We aimed to generalize the steal phenomenon conducted by the first and the second collaterals separately using t-ASL combining with MRA in MMD patients, and to explore the relationship between pre-operation hemorrhage and the steal phenomenon.

METHOD AND MATERIALS

Forty-three patients with bilateral moyamoya disease underwent t-ASL, MRA and DSA. Clinical factors including sex, age, hypertension, diabetes metabolic, hyperlipidemia, current smoking, history of taking Aspirin were gathered. Correlation analysis was used to compare the relationship between the amount of steal phenomenon and Suzuki staging. Univariate logistic regression analyses were performed to examine the relationship between pre-operation hemorrhage and each of the factors separately. Forward stepwise multivariate logistic regression analyses were performed to determine the crucial risk factor.

RESULTS

In every MMD patient steal phenomenon was positive (total amount 136). SP could be divided into five types on t-ASL images (ICA-contralateral ACA, ICA-contralateral MCA, anterior circulation-ipsilateral posterior circulation, posterior circulation-ipsilateral anterior circulation, external carotid circulation) and three groups according to MRA and t-ASL. The amount of SP was not associated with SUZUKI stage (P=0.122, 0.689). Out of all the clinical and imaging factors, high SUZUKI stage (P=0.038) and the existence of the steal phenomenon completely conducted by the second collateral (P=0.002) showed great power for predicting pre-operation hemorrhage. Forward stepwise multivariate logistic regression analyses revealed steal phenomenon completely conducted by the second collateral (OR: 29.499, 95% CI: 3.629-239.780; P =0.002) was more powerful than high SUZUKI stage (OR: 0.265, 95% CI: 0.098-0.718; P =0.009).

CONCLUSION

Steal phenomenon in MMD can be divided into five types by t-ASL and three groups according to MRA and t-ASL. Comparing with high SUZUKI stage, the existence of the steal phenomenon completely conducted by the second collateral is a stronger risk factor for pre-operation hemorrhage in MMD patients.

CLINICAL RELEVANCE/APPLICATION

Comparing with high SUZUKI stage, the existence of the steal phenomenon completely conducted by the second collateral is a stronger risk factor for pre-operation hemorrhage in MMD patients.

SSM17-03 High Resolution Time-of-Flight Magnetic Resonance Angiography with Volume Rendering Algorithm for Detection of Cerebral Aneurysms: Correlation with Standard Digital Subtraction Angiography (DSA)

Wednesday, Nov. 29 3:20PM - 3:30PM Room: N227B

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PURPOSE

We investigated the diagnostic performance and increased discriminative value of the biomarkers of high-resolution MRA(HR-MRA) with volume rendering(VR) post-processing techniques for the detection of cerebral aneurysms compared with conventional MRA(C-MRA), using digital subtraction angiography(DSA) as the gold standard.

METHOD AND MATERIALS

HR-MRA was performed for 38 patients with 51 possible aneurysms on C-MRA. For each possible aneurysm, two readers recorded their level of confidence on a 5-point scale. All patients were performed DSA, which was used as the standard of reference. ROC analysis was conducted to determine the effectiveness of C-MRA and HR-MRA in detecting aneurysm with and without VR. The sensitivity, specificity, PPV, and NPV for each category was calculated. AUC and the 95% CI of the area were computed to evaluate the detective ability. The increased discriminative value of the biomarkers was examined by calculation of NRI and IDI indices.

RESULTS

DSA revealed 37 aneurysms in 26 patients. Both in aneurysm-based and patient-based analyses, HR-MRA showed higher diagnostic accuracy than C-MRA, and when a VR algorithm was added, increased diagnostic accuracy was revealed(C-MRA vs. HR-MRA $p<0.01$; in addition of VR, $p<0.01$, respectively). Although the addition of VR to the HR-MRA did not improve the AUC(0.8031 vs. 0.8658, $p=0.16$), the IDI(19.38%, $Z=3.18$, $p<0.01$) and NRI(46.3%, $Z=6.32$, $p<0.01$) were statistically significant. When using the 5-point scale of MRA finding, C-MRA showed better performance than that of categorized MRA finding, without statistically significant difference of AUC ($p=0.27$). And the addition of VR to the HR-MRA did not improve the AUC(0.9228 vs. 0.9188, $p=0.14$), but the IDI(29.5%, $Z=4.3$, $p<0.01$) and NRI(73%, $Z=15.39$, $p<0.01$) were statistically significant. For aneurysms less than 3 mm, when HR-MRA with VR was applied, the detection rate was further increased than that of aneurysms greater than or equal to 3 mm.

CONCLUSION

The application of HR-MRA with a VR algorithm improved diagnostic performance for the detection of intracranial aneurysms, especially when the aneurysm was less than 3 mm.

CLINICAL RELEVANCE/APPLICATION

The application of HR-MRA with a VR algorithm has high accuracy, sensitivity and specificity for the detection of intracranial aneurysms, which is recommended to improve diagnostic performance for the detection of intracranial aneurysms.

SSM17-04 Comparative Study of 4D CTA and DSA for Vascular Assessment in Moyamoya Disease

Wednesday, Nov. 29 3:30PM - 3:40PM Room: N227B

Participants
Bing Tian, MD, Shanghai, China (*Presenter*) Nothing to Disclose
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Jianping Lu, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

We use 4D CTA to evaluate the vascular changes in moyamoya disease, including the vascular stenosis (modified Suzuki score, Houkin score) and collateral circulation (basicranial moyamoya vessels, posterior circulation collaterals and ECA collaterals). DSA was used as the gold standard to determine the value of noninvasive angiography in moyamoya disease.

METHOD AND MATERIALS

101 patients with confirmed moyamoya disease were underwent 4D CTA and DSA with an interval of <1 week. Two neuroradiologists evaluated the 4D CTA (VR and MIP) and DSA images independently or jointly in the case of disagreement. The performance of 4D CTA relative to DSA was determined using consistency checks (kappa values, 95% CI) and correlation analysis.

RESULTS

We obtained the following kappa values for consistency between 4D CTA and DSA: modified Suzuki score, 0.714 (0.649-0.778); Houkin score, 0.846 (0.780-0.911); the basicranial moyamoya vessels, 0.594 (0.525-0.663); posterior circulation collaterals, 0.435 (0.325-0.544); and ECA collaterals, 0.591 (0.483-0.699). The corresponding correlation coefficients (P values) were 0.843 (<0.001), 0.872 (<0.001), 0.792 (<0.001), 0.635 (<0.001) and 0.797 (<0.001).

CONCLUSION

In the evaluation of the vascular changes of moyamoya disease, 4D CTA (VR and MIP) showed strong consistency and correlation with DSA in terms of the vascular stenosis score, but was insufficient in collateral circulation evaluation.

CLINICAL RELEVANCE/APPLICATION

We adopted the modified Suzuki score and Houkin score to evaluate intracranial vascular stenosis in MMD, and also evaluated collateral circulation (the basicranial moyamoya vessels, and collaterals from the posterior circulation and ECA). Here, we discuss the value of 4D CTA for vascular assessments in adult MMD patients as compared with the gold standard, DSA. Upon analyzing the 4D CTA and DSA images of 101 adult patients with confirmed MMD, we concluded the following: (1) 4D CTA has high consistency and correlation with DSA in terms of the Suzuki and Houkin scores; and (2) 4D CTA has fair correlation and moderate consistency with DSA for the assessment of collateral circulation, specifically, the basicranial moyamoya vessels, and collaterals from the posterior circulation and ECA.

SSM17-05 4D Flow MRI Analysis of Cerebral Blood Flow Before and After High-Flow EC-IC Bypass Surgery

Wednesday, Nov. 29 3:40PM - 3:50PM Room: N227B

Awards
Trainee Research Prize - Fellow

Participants
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PURPOSE

One of the treatment options for complex ICA aneurysm is the ligation of the ICA with the high-flow extracranial-intracranial (EC-IC) bypass surgery. Though the cerebral hemodynamics is thought to be changed drastically after the surgery, there has been no published papers performing quantitative evaluation. The purpose of this study was to clarify the change of the hemodynamics after the high-flow EC-IC bypass surgery by using time-resolved 3D-phase contrast (4D Flow) MRI.

METHOD AND MATERIALS

We enrolled 11 patients (2 men; mean age 62.8) who underwent ICA ligation and high-flow EC-IC bypass surgery with radial artery graft for treatment of a complex ICA aneurysm. They underwent 4D Flow MRI preoperatively and 3 weeks after the bypass surgery. The imaging parameters; 3.0-T MRI (Aheiva, Philips), TR/TE=8.4/5.4, VENC=100cm/sec, voxel size=0.82X0.82X1.4mm, heart phase= 15, scan time= approx. 6 min. We measured blood flow volume (BFV) of bilateral ICAs, BA, and bypass artery by using GT Flow (Gyro Tools). The BFV of each vessel and total brain BFV (t-BFV = bilateral ICAs + BA + bypass) were compared between before

and after surgery by using paired t-test. We evaluated post-operative hyperperfusion based on CT perfusion and clinical symptoms within 3 weeks after the surgery.

RESULTS

In all patients, the patency of the bypass artery was confirmed by 4D Flow MRI. The BFV of contralateral ICA and BA were statistically increased after the surgery (ICA: 5.89±2.08 vs. 7.22±1.88 ml/sec (p=.0018), BA: 3.06±0.17 vs. 4.12±0.14 ml/sec (p<.001)). T-BFV was statistically increased after surgery (12.99±8.65 vs. 15.18±3.14 ml/sec (p=.0067)). While, there was no evidence of hyperperfusion in any cases based on CT perfusion or clinical symtoms.

CONCLUSION

In the current study, we could prove that the drop of BFV from sacrificed ICA is compensated by both native arteries (contralateral ICA and BA) and the bypass. Though the CT perfusion and clinical symtoms confirmed there is no hyperperfusion, the t-BFV increased 16.8%. It may indicate 4D Flow MRI could reveal the subtle hyperperfusion. In conclusion, 4D Flow MRI could quantify the change of hemodynamics after the high-flow bypass surgery. It provides insight to the autoregulation system in the cerebral blood flow.

CLINICAL RELEVANCE/APPLICATION

4D Flow MRI is one of the optimized imaging modalities for the quantitative assessment of the cerebral hemodynamic change after high-flow EC-IC bypass surgery.

SSM17-06 Angiogram-negative Non-perimesencephalic Subarachnoid Hemorrhage: A Meta-Analysis of Follow up Strategies

Wednesday, Nov. 29 3:50PM - 4:00PM Room: N227B

Participants
Long Tu, MD, New Haven, CT (*Presenter*) Nothing to Disclose
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PURPOSE

The purpose of this study is to synthesize the current literature into recommendations regarding the follow up of non-perimesencephalic subarachnoid hemorrhage. Specifically, we will investigate the utility of various imaging modalities (CTA, DSA, MRA) of repeat imaging after an initially negative angiographic study (usually CTA or DSA).

METHOD AND MATERIALS

PUBMED, EMBASE, SCOPUS and research meeting abstracts were searched up to March 2017 for studies of patients with spontaneous subarachnoid hemorrhage (SAH) and an initially negative angiographic study (DSA, CTA, or MRA). Title/abstract and then full text screening was performed by two independent reviewers. Study quality was assessed via the Cochrane Risk of Bias Tool (CRBT). Where appropriate, meta-analysis was conducted using random effects models.

RESULTS

A total of 1917 studies were identified, of which 178 underwent full text review; 95 studies were included. Diagnostic methods for initial angiographic as well as follow up studies were variable. Preliminary assessment of study quality by CRBT also showed variability; however, most studies had a low risk of bias. Preliminary data suggest superiority of DSA and CTA to MRA for follow up of angiogram-negative NPSAH.

CONCLUSION

Spontaneous SAH may be categorized as perimesencephalic, diffuse aneurysmal , peripheral (convexity, sulcal), or CT-negative (detected only on lumbar puncture) based on the distribution of acute hemorrhage. Follow up imaging for patients with perimesencephalic patterns of hemorrhage has been shown to be unlikely to find an underlying structural lesion or to change outcome for this relatively benign entity. The optimal management strategies for non-perimesencephalic SAH however are not clear. Preliminary data from our meta-analysis suggest superiority of DSA (including rotational 3D angiogram) and CTA over MRA for NPSAH with an initially negative angiographic study.

CLINICAL RELEVANCE/APPLICATION

Our study will make recommendations on the optimal management of the more concerning (non-perimesencephalic) subtypes of spontaneous SAH based on existing literature.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
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SSM18

Neuroradiology (Radiation and Image Quality)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N229

CT NR SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Margaret N. Chapman, MD, Boston , MA (*Moderator*) Nothing to Disclose
Amy F. Juliano, MD, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSM18-01 The Feasibility of One-stop Axial Scanning Coronary CTA Combined with Spiral Scanning of Head-Neck CTA: Image Quality and Radiation Dose

Wednesday, Nov. 29 3:00PM - 3:10PM Room: N229

Participants
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PURPOSE

To investigate the feasibility and advantages of ' one-stop' axial scanning of coronary and spiral scanning of head-neck CTA.

METHOD AND MATERIALS

78 patients were randomly divided into three groups: Group A (n=26) performed helical scanning of head and neck CTA and axial scanning of CCTA altogether with one-time injection of contrast medium. The switching delay between the two scanning modes was as short as 1.1 s. Group B (n=26) performed conventional head-neck CTA exams with a scanning range from aortic arch to calvarium. Group C (n=26) performed conventional CCTA scanning. The effective radiation dose (ED) and usage of contrast medium volume were recorded for each patient. Double-blinded evaluation of the image quality of the three groups were completed by two physicians.

RESULTS

The image quality of coronary and head and neck in Group A was not different from that in Group B and Group C (4.63±0.42,4.34±0.73,p>0.05). The volume of contrast medium used in Group A was significantly less that the total volume in Group B and C (53.1±3.9ml:115.2±10.6ml, t=15.9 p<0.001). The ED in Group A was not different from the combined ED in Group B and C (2.1±0.4mSv vs. 1.9±0.5mSv).

CONCLUSION

The "one-stop" scanning protocol enabled CTA of coronary and head-neck with one-time injection of contrast medium, resulting a reduction of 50% contrast medium dose, while the image quality and radiation dose were comparable with separate scanning protocols.

CLINICAL RELEVANCE/APPLICATION

The combination of axial and spiral CT angiography is the first choice for evaluation of cardiovascular and cerebrovascular diseases.

SSM18-02 Achieving Good Images in Head CT with Optimized Iterative Reconstruction Algorithm (ASIR-V) in Combination with EC2 to Further Reduce Radiation Dose

Wednesday, Nov. 29 3:10PM - 3:20PM Room: N229

Participants
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PURPOSE

To evaluate the head CT image quality and radiation dose reduction potential with optimized third generation adaptive statistical iterative reconstruction (ASIR-V).

METHOD AND MATERIALS

Prospectively enrolled 80 adults for non-enhanced head CT on a 16cm wide-detector 256-row Revolution CT scanner. Participants were randomly divided into two groups: Group 1 (n=40) with the standard low dose scan and reconstruction protocol of 120kVp / 200mAs and 60%ASIR-V algorithm; Group 2 with the reduced radiation dose of 120kVp / 120mAs scan protocol. Images in Group 2 were reconstructed using ASIR-V at 0%-100% to select the optimal strength for getting the highest subjective image quality. The subjective image quality was evaluated by 2 board-certificated radiologists using a 5-point scoring system with 3 and above being acceptable for diagnosis. Enhanced Contrast Level 2(EC2) reconstruction was done at the optimal ASIR-V (in Group 2). The CT numbers and their standard deviation (SD) of cerebellum and centrum ovale were measured to calculate signal to noise ratio (SNR) and contrast to noise ratio (CNR) for cerebellum. Radiation dose was recorded. Measurements from the two groups were compared between the optimal ASIR-V (in Group 2) in combination with EC2 and the conventional Group (Group 1).

RESULTS

With the increase of ASIR-V strength from 0% to 100%, noise decreased while CNR and SNR increased monotonically. The highest subjective image quality was achieved at 70% ASIR-V. There was no statistical difference in the noise in centrum ovale and the overall subjective image quality scores between Group 1 and the group of 70% ASIR-V in combination with EC2. However, compared with the conventional group (Group 1), the group of 70% ASIR-V in combination with EC2 significantly raised the CNR of the cerebellum by 21.4% (3.74±0.84 vs. 4.59±0.73) ($P<0.05$). On the other hand, compared with the standard low dose group, the reduced dose group with 70% ASIR-V significantly reduced effective radiation dose by 56% (0.44 vs. 1.01 mSv) ($P<0.05$).

CONCLUSION

The CT image quality of the head was acceptable on a 256-row, 16cm wide-detector CT with 70% ASIR-V algorithm in combination with EC2 at 44% dose, compared with standard low dose head CT scan and reconstruction protocol.

CLINICAL RELEVANCE/APPLICATION

Good images of the 120mAs head can be achieved on a wide-detector CT with 70% Asir-V in combination with EC2 reconstruction to reduce the radiation dose.

SSM18-03 Multiphase CT Angiography in Acute Stroke: Radiation Dose and Patterns of Use

Wednesday, Nov. 29 3:20PM - 3:30PM Room: N229

Participants
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PURPOSE

In the rapidly evolving field of acute stroke diagnosis and management, multiphase CTA (mCTA) has been recently developed, allowing better evaluation of collateral filling with temporal resolution and permitting a semi-quantitative collaterals score. To assess radiation dose and patterns of use of mCTA in a stroke referral center, we reviewed all patients who underwent mCTA. We also illustrate how the imaging protocol was modified to reduce the effective dose.

METHOD AND MATERIALS

All patients presenting with acute stroke symptoms who underwent our stroke imaging protocol were retrospectively evaluated. The protocol consists of non-contrast CT (NCCT) and mCTA. After intracranial hemorrhage was excluded on NCCT, mCTA was performed. Most patients were imaged on a Siemens Somatom Definition scanner. In case the former was unavailable a Philips Brilliance 16 was used. Scan parameters are shown in Tables 1 and 2. Iodine-based contrast medium (60mL,370mg/mL) was injected at 5mL/s followed by 40mL of saline solution at 5mL/s. From April 2017 the 3 mCTA phases on Definition were lowered from 120kVp to 100kVp, keeping the other parameters constant. The assessment of organ doses (brain and lens) was performed on stylized human phantoms implemented in CT-Expo v2.3 software.

RESULTS

From 1st June 2015 to April 10th 2017 we analyzed 274 consecutive patients who underwent NCCT and mCTA (median age 68, range 14-92, males percentage 56%). Radiation doses are reported in Tables 1 and 2. Effective dose (according to ICRP 103) ranges from 9.4 to 10.4mSv for the old protocols, aligned with previous reports for mCTA, and lower than the protocols including CT perfusion, in particular for eye lens. The new 100kVp protocol allows a reduction of the effective dose of 30%, from 10.4 to 7.3 mSv.

CONCLUSION

The NCCT+mCTA protocol was designed to be fast to perform and interpret, in order to provide critical information on brain parenchyma and vasculature while minimizing door-to-groin time in patients who are candidates for mechanical thrombectomy. By

lowering voltage of mCTA to 100kVp the effective dose reduction was substantial, without perceived loss of diagnostic accuracy from multiple viewers and even enhancing arterial contrast.

CLINICAL RELEVANCE/APPLICATION

Multiphase CT angiography as part of an acute stroke imaging protocol is associated with low radiation dose and provides critical information on brain parenchyma and vasculature.

SSM18-04 Carotid-CTA at 70 Kilovolt (kV) in Comparison to Automated Tube Voltage Adaption in Respect to Radiation Exposure and Image Quality

Wednesday, Nov. 29 3:30PM - 3:40PM Room: N229

Participants
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PURPOSE

To evaluate a 70 kV protocol in computed tomography angiography (CTA) of the carotid arteries in respect to image quality and radiation exposure compared to automated tube voltage adaption.

METHOD AND MATERIALS

Ninety consecutive patients were included in this prospective study. Fourty-five (64, 35 - 84 years) were randomized to the study group (70 kV, 167 ref.mAs) and 45 (65, 24 - 87 years) were randomized to the control group (automated kV adaption, 70 - 150 kV). CT dose index (CTDIvol) and dose length product (DLP) were recorded from the examination protocol. Image quality was assessed by region of interest (ROI) measurements and calculations of signal to noise (SNR) and contrast to noise ratio (CNR). Subjective image quality and image artifacts were evaluated by two observers with a 4-point scale (3-excellent; 0-not diagnostic).

RESULTS

Radiation exposure was significantly lower in the study group (CTDIvol reduction of 22%, DLP reduction 20%; each $p<0.001$). Contrast ($p=0.15$), SNR ($p=0.4$), and CNR ($p=0.5$) did not show significant differences between the groups. Subjective image quality was without significant differences between the two groups ($p=0.56$). Also artifacts due to contrast medium influx were without significant difference ($p=0.17$). Artifacts due to beam hardening in the height of the shoulder girdle were significantly more affecting in the scans from the study group ($p=0.04$) while there was also no significant difference on the height of the skull base ($p=0.65$).

CONCLUSION

Carotid-CTA using fixed 70 kV is feasible at very low radiation dose levels while overall image quality is constant to protocols using automated tube voltage selection.

CLINICAL RELEVANCE/APPLICATION

Lowest available tube voltages (70 kV) can increase the radiation dose efficiency in CT angiographies of the carotids compared to individual tube voltage adaptation.

SSM18-05 Dual Energy CT Angiography of the Carotid Arteries: Quality, Bone Subtraction and Radiation Dosage Using Second- and Third-Generation Dual-Source CT

Wednesday, Nov. 29 3:40PM - 3:50PM Room: N229

Participants
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PURPOSE

To study the differences in vascular image quality, bone substraction, and dose of radiation of dual energy CT angiography (CTA) of the supraaotic trunks using second- and third-generation dual-source CT (DSCT). Comparing the diagnostic performance of arterial stenosis between the third-generation dual-source CT and digital subtracted angiography (DSA).

METHOD AND MATERIALS

CTA of the supraaortic trunks in 40 patients were retrospectively reviewed. 20 patients used second-generation dual-energy CT (DECT) system (100/Sn140 kp tube voltage) and 40-mL contrast material. Another 20 patients used third-generationDECT system (90/Sn150 kV tube voltage) and 30-mL contrast material. The attenuation was measured in common carotid artery (CCA), C7 segment of internal carotid arteries, and cervical muscle (CM). The noise of CCA and CM was recorded. The signal-to-noise ratio (SNR) of CCA and contrast-to-noise ratio (CNR) were calculated. 5-scoring system was used for bone removal of C1-C7 segments of internal carotid arteries (1=poor, 5=excellent). DSA was performed if necessary. Accuracy, sensibility, specificity were calcuated.

RESULTS

The attenuation of third-generation group was significant higher on C7 (P=0.001), and not different on CCA (all P = 0.317) compared with that of second-generation group.Both SNR and CNR of CCA were significantly higher in second-generation group than third-generation group (both p < 0.05). The dose-length product in second-generation group was lower than that of third-generation group (299.7 ± 16.7 vs. 218.3 ± 27.8 mGy×cm, P<0.001).Scores of the bone removal of C2, C3, C4 and C7 were were evaluated as 5 score in the third-generation group, which were higher than that of second-generation group were lower (all P < 0.05). 6 patients in the third-generation group received DSA examination, the accuracy, sensibility, specificity for detecting >50% arterial stenosis were 98.8%, 100% and 98.8%.

CONCLUSION

Third-generation dual-energy scan mode is is able to decrease the volume of contrast material, reduce the radiation dose and improve the image quality of bone removal compared with second-generation grouu. the accuracy, sensibility, specificity are high compared with DSA.

CLINICAL RELEVANCE/APPLICATION

Dual-energy scan mode of third-generation CT provides better bone-subtraction quality of carotid arteries and is equal to DSA in detecting arterial stenosis.

SSM18-06 Using a Low Tube Voltage Protocol with Adaptive Statistical Iterative Reconstruction in Craniocervical Computed Tomographic Angiography Provides Better Image Quality with a Reduced Radiation Dose

Wednesday, Nov. 29 3:50PM - 4:00PM Room: N229

Participants
Chih-Wei Chen, MD, Kaohsiung City, Taiwan (*Presenter*) Nothing to Disclose
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Ping-Hong Lai, Kaohsiung, Taiwan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate image quality and radiation dose by using a lower kVp protocol (100 kVp) and 50% ASiR-V for Craniocervical Computed Tomographic Angiography (CCCTA) in comparison with the conventional protocol (120 kVp).

METHOD AND MATERIALS

A total of 121 volunteers (47 men, 74 women; age range, 15-78 years) were enrolled and randomly divided into 3 groups: group A (conventional protocol): 120 kVp and filtered back-projection reconstruction; group B: 120 kVp and 50% ASiR-V; group C: 100 kVp and 50% ASiR-V. All patients were scanned by a 256-slice CT machine with the slice thickness of 0.625 mm. Objective values(arterial attenuation value, signal-to-noise ratio [SNR], contrast-to-noise ratio [CNR]) of arteries was obtained at head, neck and shoulder levels and compared among three groups. Subjective image quality and radiation dose (volume CT dose index [CTDIvol], dose-length product [DLP]) were also compared. The quantitative parameters and radiation dose were analysis by ANOVA. Subjective image quality was evaluated by two experienced radiologists independently and inter-rater reliability was calculated using kappa (k) analysis.

RESULTS

For the radiation dose, the CTDIvol and DLP of group C were the lowest among three groups. For the objective values, the arterial attenuation in head, neck and shoulder were significant higher in group C than those in group A and B (each P <0.05). The SNR and CNR of group B and C were significant higher than the conventional group A (each P <0.05), and there were no significant difference for the SNR and CNR between group B and C. In subjective image quality analysis, group C revealed significant better image quality than group A and B (P <0.05). The inter-rater reliability was good (k=0.73).

CONCLUSION

In CCCTA, using 100 kVp and 50% ASiR-V protocol showed better arterial attenuation, SNR, CNR and subjective imaging quality with a reduced radiation dose compared to the conventional protocol.

CLINICAL RELEVANCE/APPLICATION

Using ASiR-V with a lower kVp protocol in CCCTA, better objective and subjective imaging quality can be obtained with a reduced radiation dose compared to the conventional protocol.

SSM19

Pediatrics (Interventional Radiology)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S102CD

IR PD US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Kamlesh U. Kukreja, MD, Bellaire, TX (*Moderator*) Nothing to Disclose
Anne Marie Cahill, MBBCh, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSM19-01 Pediatric Percutaneous Renal Biopsies: Comparison of Complications between Real-Time Ultrasound Guidance and Ultrasound Marking Techniques

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S102CD

Participants
Shireen Hayatghaibi, MA, MPH, Houston, TX (*Presenter*) Nothing to Disclose
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PURPOSE

To compare the complications from percutaneous renal biopsies performed using real time ultrasound-guidance versus pre-procedure ultrasound-aided skin marking in children.

METHOD AND MATERIALS

An a priori analysis yielded a sample size of 850 procedures required to detect a difference in complications between the two groups (power: 0.8). Consecutive patients who underwent a percutaneous renal biopsy at our tertiary care academic medical center were retrospectively identified. Demographic information, biopsy technique, and post-biopsy complications were recorded. Complications were categorized according to Society of Interventional Radiology (SIR) criteria. Complication rates were compared using Fisher's exact test.

RESULTS

The study population consisted of 850 renal biopsy procedures in 626 patients. Real-time ultrasound guidance was performed in 375 biopsies (age range: 0-29, mean: 12.1 yrs); 475 biopsies used pre-procedure ultrasound-aided skin marking (age range: 2-27, mean: 13.6 yrs). Diagnostic yield was obtained in all biopsies with real-time ultrasound (mean cores: 2.63+/-1.52) and in 471/475 (99.2%) of those using pre-procedure skin marking (mean cores: 2.64+/- 0.72; p=0.91). Overall, 283 (33.3% of biopsies) complications were detected in the study cohort; 60 (16% of biopsies) in the real-time ultrasound guidance group and 223 (47% of biopies) in the conventional skin marking group (p<0.001). In the real-time ultrasound group, 43 complications (11.5% of biopsies) were SIR A and 8 (2.1% of biopsies) SIR B. In the skin marking group, 156 (32.8%) biopsies resulted in SIR A complications and 54 (11.4%) SIR B. The groups were statistically different for both SIR A (p<0.001) and SIR B (p<0.001) complications. There was no detectable difference in major complications between the groups [p=0.83; real-time ultrasound guided: 6 (1.6%) SIR C and 3 (0.8%) SIR D; skin marking: 12 (2.5%) SIR C and 1 (0.2%) SIR D].

CONCLUSION

Patients who underwent real-time ultrasound-guided renal biopsies had significantly fewer minor complications, including those that required follow-up medical care (SIR B), compared to those who underwent pre-procedure ultrasound-aided skin marking.

CLINICAL RELEVANCE/APPLICATION

Patients with an ultrasound-guided renal biopsy required less additional medical care for complications. This is important in value based healthcare that pursues quality outcomes at controlled costs.

SSM19-02 Onyx Embolization in Pediatric Neuro-interventional Procedures

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S102CD

Participants
Tahaamin Shokuhfar, MD, Chicago, IL (*Presenter*) Nothing to Disclose
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PURPOSE

Although AVMs are rare among pediatric population, nearly half of spontaneous intracranial hemorrhages in children are due to these malformations. Onyx, as an FDA approved embolizant for adults, has limited studies regarding its safety and efficacy among children. Here, we evaluate the safety and efficacy of Onyx embolization in pediatric neurointerventional procedures.

METHOD AND MATERIALS

In this study, all pediatric Onyx embolization of intracranial AVM cases are evaluated over a period of 10 years. Medical record and radiology imaging were reviewed for each patient regarding demographic data, clinical presentations, embolization procedure and related complications.

RESULTS

Seventy-two patients (female = 26 (36%)) with intracranial AVMs underwent total of 122 embolization procedures. Age of patients ranged between 1 month to 17 years with the mean of 10.2 years. Forty-four patients underwent a single embolization procedure and staged embolization was required for the remaining 28 patients prior to definitive treatment. Onyx embolization resulted in complete occlusion of the AVM in 10 patients (14%). A total of 66 patients underwent subsequent surgical treatment. Overall 13 complications occurred in total of 122 Onyx embolizations (10.6%) which resulted in 7 transient neurological deficits and 6 clinically silent complications (Table 1). None of the complications resulted in mortality or permanent morbidity. No significant demographic characteristic differences observed in patients with or without complications.

CONCLUSION

In this study we propose the safe and effective utilization of Onyx for embolization of pediatric cerebral AVMs. The relative low rate of complications (10.6%) along with no mortality or permanent morbidity, suggests the safe utilization of Onyx as a preoperative or primary embolization treatment of pediatric intracranial AVMs. However, specific attention should be considered for its indications and technical limitations according to the broad spectrum of complications.

CLINICAL RELEVANCE/APPLICATION

Onyx utilization can be feasible for preoperative or primary embolization in the treatment of pediatric AVMs. We report here the largest series of Onyx embolizations of brain AVMs in the pediatric population. The results, in terms of clinical and angiographic improvement, with a low rate of transient morbidity and no permanent morbidity or mortality, are encouraging.

SSM19-03 Magnetic Resonance-Guided Focused Ultrasound Surgery for Treatment of Osteoid Osteoma in Pediatric Patients Only: A Multicenter Experience

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S102CD

Participants
Francesco Arrigoni, Coppito, Italy (*Presenter*) Nothing to Disclose
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PURPOSE

To retrospectively evaluate the effectiveness and safety of MRgFUS of Osteoid Osteoma in paediatric patients (age <18 years) based on the experience of three university hospitals. Since OOs mostly affect patients in paediatric age, it is of paramount importance that the employed techniques be as minimally invasive as possible. MRgFUS aims to become the standard care, producing no skin lesion or damage to the soft tissues.

METHOD AND MATERIALS

Over a period of 4 years, we used MRgFUS on 33 patients (age <18 years, mean 13.8) affected by symptomatic non-spinal Osteoid Osteoma. Inclusion criteria were: (i) clinical diagnosis of osteoid osteoma (pain, more typically nocturnal, relieved by NSAIDs: mean pre-treatment VAS value: 7.5 (CI: 4-10)); (ii) positive imaging for OO with typical features; (iii) subperiosteal or cortical lesions only: a periosteal reaction or a cortical thickening (more than 6 mm) surrounding the lesion was considered as a technical contraindication for MRgFUS treatment. The outcomes were evaluated with clinical and imaging follow-up studies up to 5 and 3 years, respectively.

RESULTS

After treatment, absence of pain was observed in 31 patients (94% of complete success; VAS: 0), confirming the effectiveness of the procedure. One patient reported VAS: 1 during follow-up, but because the condition was considered satisfactory by the patient, an additional treatment was not deemed necessary. Only one patient was treated twice to obtain complete pain relief. Nor relapse or complications were observed. The long term imaging control showed a progressive restoration to the original condition of the bone segments without signs of treatment or residual inflammatory findings.

CONCLUSION

MRgFUS is safe and effective for treatment of selected localizations of osteoid osteoma; for superficial lesions it could be

MRgFUS is safe and effective for treatment of selected localizations of osteoid osteoma. For superficial lesions it could be considered the first and definitive choice for patients in paediatric age. The possibility of treating only subperiosteal or cortical lesions is a limit but non too notable, because the greater part of the osteoid osteomas belong to these two categories. This touch-less approach does not leave any sign of the procedure nor interference with the normal growth of the bone.

CLINICAL RELEVANCE/APPLICATION

This treatment could represent the less invasive step for the treatment of Osteoid Osteoma.

SSM19-04 Mynxgrip Vascular Closure Device Use in Pediatric Neurointerventional Procedures

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S102CD

Participants
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PURPOSE

The application of arterial closure devices has been broadly investigated and previously approved in adults but their feasibility and safety have not been approved in pediatric patients and any application of such devices in children is considered off-label. The decision to use the Mynxgrip in our practice has been made based on the low reported rate of complications in adults and the fact of no intra-luminal component regarding the usage of Mynxgrip.

METHOD AND MATERIALS

A Retrospective review of all pediatric patients undergoing diagnostic or interventional neurovascular procedures was conducted. Mynxgrip was applied to any pediatric patient with adequate depth of subcutaneous tissue and common femoral artery (CFA) diameter. Patients' demographic and procedural data was recorded. Hemostasis status and complication reassessment for outpatients and pre-operational inpatients were documented.

RESULTS

During the period of 36 months, a total of 83 Mynxgrip was deployed on 53 children (23 male and 30 female, mean age = 14.5 years) undergoing diagnostic/interventional neuro-endovascular procedures through common femoral artery access site. About 46% procedures were diagnostic angiography and the remaining were angiography with embolization. CFAs' diameter were ranged between 4mm to 8.5mm with the average diameter of 6.24 (SD± 1.16). Deployment of Mynxgrip was successful in 82 procedures (98.8%). There was a single (1.2%) device failure and no other immediate or delayed major complications were recorded.

CONCLUSION

Comparing with the manual compression as the current standard of care, the application of Mynxgrip in our practice brought immediate hemostasis at common femoral artery access site, along with earlier ambulation and shorter duration of hospitalization.

CLINICAL RELEVANCE/APPLICATION

To the best of our knowledge, current study is the first report of the application of Mynxgrip arterial closure device among pediatric population. We reported the feasibility of Mynxgrip as a safe and efficient way of hemostasis achievement at CFA arteriotomy site in children undergoing diagnostic or neuro-interventional procedures.

SSM19-05 Percutaneous Ablation of Malignant and Locally Aggressive Solid Tumor in Pediatric Patients

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S102CD

Participants
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PURPOSE

Present the oncologic outcomes of our series of pediatric patients treated with ablation for primary and metastatic cancers.

METHOD AND MATERIALS

Retrospective review of a HIPAA compliant prospectively maintained percutaneous ablation database. All ablations performed in patients younger than 18 years since 2002 were reviewed. RFA was performed using the the Cool-tip system (Covidien, Boulder, CO). Cryoablation was performed using the Endocare system (HealthTronics, Inc. Austin TX).Patients were watched for 4 hours after ablation and discharged home in the absence of complications. Patients were admitted for pain or other complications. CT and/or PET/CT scan was obtained 1 month after ablation. Subsequent imaging studies were obtained as indicated by the pediatric oncologist to assess for findings of local tumor progression (LTP). Patient and tumor characteristics were described and summarized. Survival end points of interest include overall survival (OS) and local tumor progression free survival (LTPFS) . Survival end points were analyzed using Kaplan-Meier method.

RESULTS

8 pediatric patients were identified in our database that includes 1471 patients treated with ablation since 2002. There were 4 males and 4 females. Mean age was 12.8 years (range 3 - 17). Mean weight was 49.5 kilos (15 - 60 kilos). These 8 patients underwent 12 ablations to treat 9 lesions. Mean lesion size was 3.4 cm (Range 0.8 -7.8 cm). Mean hospital stay was 2.1 days (median 2.3 days, range 0-4). There was one major complication (SIR classification D) in a patient with lung metastases from chondrosarcoma. He developed parenchymal bleeding that required intubation for less than 24 hrs. Mean follow up was 79 months. OS at 5 years was 75%. Median LTPFS was not reached. At the end of follow up 2 lesions developed LTP. LTPFS rates were 88% at 1 year and 77% at five years .

CONCLUSION

Ablation can be performed safely and effectively in a carefully selected group of pediatric patients with cancer. We consider that the use of these technologies should be used more often and in conjunction with other cancer treatments, always in the setting of multidisciplinary consensus.

CLINICAL RELEVANCE/APPLICATION

Ablation can be performed safely and with good results in pediatric patients.

SSM19-06 Transjugular Intrahepatic Portosystemic Shunts (TIPS): Safety and Efficacy in the Pediatric Population

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S102CD

Awards
Student Travel Stipend Award

Participants
Zachary S. Jeng, MD, Houston, TX (*Presenter*) Nothing to Disclose
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PURPOSE

To report the experience of a tertiary pediatric referral center with creation and revision of transjugular intrahepatic portosystemic shunts (TIPS) in children and adolescents.

METHOD AND MATERIALS

10 consecutive patients over a 10 year period with 9 undergoing TIPS creation and 1 undergoing TIPS revision (initially placed at an outside institution). 8 patients were under the age of 18: 2 infants (ages 9 and 10 mos), 5 children (ages ranging from 5 y, 11 mo to 12 y, 1 mo), and 1 adolescent (age 16 y, 6 mo). All had gastroesophageal variceal bleeding as the reason for TIPS creation/revision. Causes of liver dysfunction were biliary atresia in 5 patients, cystic fibrosis in 1, veno-occlusive disease secondary to chemotherapy in 1, and Ellis-van Creveld Syndrome in 1.

RESULTS

The technical success rate was 100%. 6 patients received Viatorr endografts while 1 patient received a Luminex endograft and a Wallstent. 4 TIPS were created using a 10 mm endograft, 2 using an 8 mm endograft, and 1 using a 2 cm endograft. The mean portosystemic pressure gradient was reduced from 19 mmHg to 8 mmHg. Flow was successfully restored in the patient undergoing TIPS revision. Primary patency during initial ultrasound follow-up performed 1 to 2 days post procedure was 100%. Follow-up imaging performed up to 23 months post procedure demonstrated 100% stent patency. There were no major complications or mortalities associated with TIPS creation. One patient continued to experience intermittent hemoptysis, though likely related to underlying cystic fibrosis, while one developed a single episode of transient hyperammonemia. One patient underwent balloon angioplasty 3 days post TIPS creation for decreased hemoglobin and concern for GI bleeding with no stenosis or thrombosis discovered on portal venogram. There were no other repeat interventions, shunt dysfunctions, or recurrent episodes of GI bleeding. 6 children have since received hepatic transplants with 3 children receiving transplants 23, 20, and 8 days post TIPS creation.

CONCLUSION

TIPS placement can be successfully performed in young pediatric patients with low complications rates and excellent initial and intermediate patency.

CLINICAL RELEVANCE/APPLICATION

TIPS is a well-documented method for treating portal HTN and its sequela in adults. With increasing use in the pediatric population, we wanted to determine its effectiveness and safety in children.

SSM20

Physics (MR: New Techniques)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S403A

MR PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Timothy J. Carroll, PhD, Chicago, IL (*Moderator*) Nothing to Disclose
Geoffrey D. Clarke, PhD, San Antonio, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSM20-01 Hyperpolarized Water as an Alternative MRI Contrast Agent

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S403A

Participants
Sebastian Fischer, MD, Frankfurt, Germany (*Presenter*) Nothing to Disclose
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CONCLUSION

Hyperpolarized water might be a promising future alternative to Gadolinium based contrast agents in MR angiography or even further diagnostics without risking the potential adverse effects or intracorporal remnants of Gadolinium based contrast agents.

Background

The administration of Gadolinium based contrast agents is associated with the risk of allergic reactions and the development of a systemic nephrogenic fibrosis (NSF). Current research showed remnants of some types of Gadolinium based MR contrast agents in the brain - with unknown long-term effects. Purpose of our work is the development of an alternative method to create MRI contrast by using dynamic nuclear polarization (DNP). The tested liquid-state Overhauser DNP is a technique to achieve hyperpolarization by microwave irradiation of electron spins in TEMPOL radicals, which are coupled with the nuclear spins of water molecules.

Evaluation

Our setup comprises a 42 GHz microwave source and an in-bore DNP polarizer, equipped with a multimode resonator inside a standard clinical 1.5 T scanner, which allows a continuous hyperpolarization of water molecules with a flow rate about 1.2 ml/min. In this work we characterized the performance of the DNP setup for MR imaging in various vascular models by comparing it to standard Gadolinium-based contrast media. We used 2D and 3D scan protocols with GRE- and VIBE-sequences for measurements, which feature up to a 30-fold signal enhancement of the hyperpolarized aqueous solution. A comparison to Gadolinium enhanced signals of physiologic intravascular conditions shows 12-fold enhancement rates and an increased absolute sensitivity.

Discussion

The used liquid state in-bore DNP setup creates hyperpolarized water, which features high T1 MR signal enhancements and a short relaxation time. SNR and CNR values were substantially improved by DNP and capillary diameters down to 75µm could be visualized. In our comparing experiments the hyperpolarized water showed an enhancement higher than gadolinium, which allows imaging down to small vascular structures in a standard clinical 1.5 T scanner.

SSM20-02 Intravoxel Incoherent Motion Diffusion-weighted Imaging of Bone Marrow Microstructure in Patients with Acute Leukemia

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S403A

Participants
Jinliang Niu, MD, PhD, Taiyuan, China (*Presenter*) Nothing to Disclose
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PURPOSE

Intravoxel Incoherent Motion Diffusion-weighted Imaging of Bone Marrow Microstructure in Patients with Acute Leukemia

METHOD AND MATERIALS

28 patients with AL underwent MRI scans at 1.5T using conventional diffusion weighted imaging (DWI) and IVIM (b= 0, 10, 25, 50, 100, 200, 400, 600, 800, 1000, 1200s/mm2) in the sagittal plane covering the lumbar bone marrow before standard chemotherapy. The IVIM parameters (perfusion fraction [f], molecular diffusion coefficient [D], and perfusion-related D [D*] and apparent diffusion coefficient (ADC) were extracted from the bone marrow images. The microvessel density (MVD) and vascular endothelial growth factor(VEGF) was confirmed by bone marrow biopsy of the iliac crests, whichwere used to evaluate bone marrow microstructure. All patients were divided into complete remission (CR) and non-remission (NR) group according to the treatment response.

RESULTS

All patients underwent the first remission induction chemotherapy, with 19 patients achieved CR and 9 patients achieved NR.The ADC and D* values were not significant different between the two groups. However, D value of CR group was significantly higher (p=0.003), and f value of CR group was significantly lower (p=0.039) than those of NR group. Using receiver operator characteristic (ROC) analysis, the area under the curve (AUC) of D and f were 0.848 and 0.746 respectively in evaluating prognosis of AL before treatment. The fshowed significantly statistical correlations with MVD (r= 0.384) and VEGF (r= 0.439).

CONCLUSION

The D , f value ofbone marrow could play a potential role in prognosticating patients with AL. The f value could be used as noninvasive biomarkers to evaluate the microstructure bone marrow.

CLINICAL RELEVANCE/APPLICATION

Evaluation of bone marrow microstructure and prognosis of leukemia patients

SSM20-03 Auto-Calibrated Correlation Time Diffusion Brain qMRI and the Principle of Diffusional Homeostasis

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S403A

Participants
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CONCLUSION

A fully automated and auto-calibrating DCT mapping algorithm has been developed and could be useful for aiding in the diagnosis of pathologic entities that disrupt diffusional homeostasis such as acute ischemic stroke.

Background

Standard diffusion MRI is based on the pulsed field gradient (PFG) experiment and probes molecular water motions at the 10-100millisecond time scale depending on experimental conditions. Despite the very different water micro-environment in gray matter (GM) and white matter (WM), one of the most remarkable findings of DPFG MRI is the near equality of the mean diffusivities of water in both tissues at diffusion times reported in the literature. Correlation time diffusion (DCT) MRI is based on T1 relaxometry and therefore probes water diffusion at the very short time scale of the correlation time: approximately 20ps for brain tissue. We hypothesize that the herein termed "*principle of diffusional homeostasis*" is valid at such short time scales and apply it to develop a self-calibrating DCT mapping algorithm whereby the one external model parameter -specifically, the magnetization transfer coupling constant (kappa in Fig. 1)-- is auto-determined by minimizing the WM-to-GM diffusional differences to within one half the standard deviation.

Evaluation

This is a HIPAA compliant prospective study approved by the local IRB that included ten patients without major abnormalities ranging in age from 2 to 87years. MR images acquired with the mixed turbo spin echo pulse (mixed-TSE) sequence were qMRI processed generating maps of T1, T2, and PD. These maps were used to generate DCT maps using an algorithm which calculates the pure correlation time without magnetization transfer effects. In all ten cases, the DCT maps were in quantitative agreement (<5%) with the DPFG maps for GM, WM, and cerebrospinal fluid.

Discussion

The developed fully auto-calibrating DCT mapping algorithm is based on the assumption of diffusional homeostasis, which is supported by a wealth of DPFG evidence in the healthy brain. Differences between DCT and DPFG may arise in pathologic conditions whereby the long time scale diffusion tissue properties may be abnormal via restricted diffusion.

SSM20-04 Metal Artifact Reduction for Myocardial Scar Assessment in Patients with Cardiac Implanted Electronic Devices Using Cardiac Magnetic Resonance

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S403A

Participants
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Maryam Ghadimi Mahani, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

Anil K. Attili, MD, Saline, MI (*Abstract Co-Author*) Nothing to Disclose
Thomas L. Chenevert, PhD, Ann Arbor, MI (*Abstract Co-Author*) Consultant, Koninklijke Philips NV

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CONCLUSION

The developed wideband IR technique minimizes the CIED-generated hyperintensity artifacts without increasing scan time, and allows for accurate identification of arrhythmogenic substrate in VT patients.

Background

An important application of late gadolinium enhancement (LGE) cardiac magnetic resoncance (CMR) is assessment of myocardial scar in patients with ventricular tachycardia (VT) before ablation. LGE imaging in patients with cardiac implanted electronic devices (CIEDs) is challenging because of device-generated metal artifacts that compromise the effect of the inversion recovery (IR) pulse and obscure the region of interest. In 2016 we have performed 180 CMRs in patients with CIED at our institution. In this abstract we will discuss the use of modified IR technique to alleviate metal artifacts and improve diagnostic image quality.

Evaluation

The modified sequence includes a wideband IR pulse with adjustable frequency offset and bandwidth, which allows for optimal myocardial signal nulling in the presence of off-resonance effects. A phantom experiment was conducted on a 1.5T scanner using conventional and wideband IR sequences with different frequency offset and bandwidth (BW) values. Then, 20 patients (18 males, age=62±17) with CIEDs (8 Boston Scientific, 10 Medtronic, and 2 St Jude) were imaged on the same scanner using the conventional and optimized wideband LGE techniques prior to ablation. The imaging parameters were optimized for each patient. Conventional IR sequence resulted in severe artifacts that obscured ventricular segments in 15 out of 20 patients. The wideband IR sequence significantly minimized the artifacts. Optimal BW was in the range of 2000-3000Hz with optimal frequency shift up to 1000Hz.

Discussion

Increasing the IR frequency BW results in better artifact reduction, although this comes at the cost of incomplete myocardial nulling. So, BW should be set to the minimum value that eliminates the artifact, which is affected by the device type and location. Similarly, the frequency offset of the IR pulse affects the artifact appearance, so proper setting of the frequency offset could allow for removing the artifact without the need to increase the frequency BW.

SSM20-05 TSE-Based DWI of the Prostate as an Alternative to SS-SE-EPI DWI

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S403A

Participants
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Lidia Alcala Mata, MD, Jaen, Spain (*Abstract Co-Author*) Nothing to Disclose
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Javier Sanchez, MD, PhD, Madrid, Spain (*Abstract Co-Author*) Nothing to Disclose

CONCLUSION

DWI TSE has a potential role as an alternative to SS-SE-EPI DWI in MR protocols for prostate cancer detection.

Background

DWI is a key MR imaging contrast for prostate cancer detection. In clinical practice, a SS-SE-EPI sequence is used. EPI readout is prone to geometrical distortion and susceptibility artifact due to the presence of air content within the rectum or metallic implants. These limitations make more difficult the proper spatial localization of the lesions. Also, the use of DWI to localize suspicious areas in targeted MR/ultrasound fusion guided biopsy is limited. Turbo Spin Echo-based DWI is proposed as a potential alternative to eliminate geometric distortion and local susceptibility artefacts. In this presentation, its geometric validation is performed to demonstrate spatial accuracy of DWI-TSE images compared with conventional DWI-SE-EPI sequence.

Evaluation

All images were acquired in a 3.0 T Achieva scanner (Philips Healthcare, The Netherlands) with a 16ch body coil on 15 patients with prostate cancer in targeted MR/ultrasound guided biopsy. On these patient, two DWI sequence were performed with equal b values (0, 1000 and 1500 s/mm2) wit DWI-SE-EPI (TR/TE=4500/90ms) and DWI-TSE (TR/TE=11173/131ms) sequences. DWI images were acquired in the same orientation of conventional TSE T2-weighted sequence. Both acquisitions shared equivalent spatial resolution (2.6x2.8x4.5 mm3) with no gap between slices. Total scan time was 118s and 290s for SS-SE-EPI and TSE respectively. ADC maps were calculated using b0 and b 1000 s/mm2 for both sequences. SNR and CNR were compared for all b values and ADC maps. Also, the presence of geometric distortion and susceptibility artifacts was recorded. Both sequences were also compared to target prostate biopsy using an specific MR/ultrasound fusion device.

Discussion

TSE-based DWI presented free geometric distorted images in all cases with similar CNR, although with a moderate increase in acquisition time. Also, this approach permits to delineate lesions for targeted biopsy with advantage over SS-SE-EPI DW-sequence due to good geometrical performance.

SSM20-06 Measuring Frequency Drift in MR Spectroscopy on a 3 T MRI

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S403A

Participants

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CONCLUSION

Change in gradient temperature from heavy usage negatively impacts scanning quality for MRS sequences. Methods exist to compensate for frequency drift, but significant drift can still negatively impact quantification of the metabolite concentrations due to the poor water suppression. Quantifying the time required for gradients to stabilize after intense use, in this example of a Siemens Skyra 3 T, can inform scheduling of MRS studies to maximize their stability, and reduce the need for drift correction tools.

Background

MR spectroscopy (MRS) is susceptible to frequency drift caused by gradient warming, more so than other MR imaging modalities. Frequent switching of gradients in fMRI and DTI causes heating and the frequency of the magnet to change in an unpredictable way. Frequency drift in functional brain imaging can cause spatial drift over time, especially in the z direction, but is easily corrected by realignment. Frequency drift in MRS degrades the water suppression and quality of the spectrum through increased linewidth. We examine the effects of gradient heating on frequency drift and map the time required for gradients to stabilize on a specific magnet.

Evaluation

Drift was tested on a Siemens 3 T Skyra MRI, with a 32-channel receive-only head-coil, standard gradients, and an MRS phantom. Using a PRESS sequence, transmitter voltage and water suppression flip angle were adjusted to produce optimal water suppression. At 10 minute intervals over a period of 3 hours, magnet frequency was adjusted to convergence and the new frequency recorded. Two 9 min fMRI sequences (TR = 700ms) were run starting 20 minutes after initial frequency measurement.

Discussion

Frequency drift was negligible prior to perturbation of gradients from fMRI, but increased 5.6Hz/min to a peak of 70 Hz above baseline after the second fMRI sequence. Frequency returned to baseline 120 minutes after completion fMRI at a rate of 0.83 Hz/min for the first 60 minutes. Spectra collected using LASER sequence after perturbation showed significant drift, and spectra collected before perturbation showed no drift.

SSM21

Radiation Oncology (Breast Cancer)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S105AB

BR RO OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM21-01 Outcomes of Early Stage Breast Cancer with Nodal Micrometastases

Wednesday, Nov. 29 3:00PM - 3:10PM Room: S105AB

Participants
Yazan A. Abuodeh, MBBS, Tampa, FL (*Presenter*) Nothing to Disclose

ABSTRACT

Purpose/Objective(s): Nodal micrometastases (N1mi) in breast cancer patients carry a slightly worse prognosis compared to node negative disease. This study aims to assess factors predictive of N1mi outcome and the effect of treatment modality for this cohort.Materials/Methods: Retrospective analysis of T0-T2 N1mi breast cancer patients were obtained by chart review and the Total Cancer Care Database from 2000-2014. Patient, tumor, and treatment characteristics were analyzed in regards to outcome, which include: locoregional failure (LRF), distant metastasis (DM), disease free survival (DFS), and overall survival (OS). Cox-regression univariate (UVA) and multivariate (MVA) analyses were used to determine association between variables and outcome. Variables predictive of outcome on UVA (pResults: We identified 129 female breast cancer patients with stage IB/IIB, with a median age of 58 (30-58) years. Patients were most commonly Caucasian (85%) with left breast involvement (54%). Patients were either treated with breast conserving therapy (BCT) (n=48,37%), mastectomy only (n=52, 40%), or mastectomy with postmastectomy radiation (PMRT) (n=29, 23%).” Axillary evaluation was either by sentinel biopsy alone (n=85, 66%) or by axillary dissection (n=44, 34%). Invasive ductal carcinoma was found in 106 (82%) patients. Tumor stage was primarily T1 (46.5%) and T2 (51.9%), with 2 (1.6%) T0. Median tumor size was 2(0-5) cm. Grades were 1,2,3, and unknown in 24(18.6%),66 (51.2%),38(29.5%) and 1(0.8%), respectively. Multifocal disease (MF) and lymphovascular space invasion (LVSI) were present in 29(22.5%) and 32(24.8%) patients, respectively. Number of involved lymph nodes were 1, 2, 3 in 115(89%), 11(9%), and 3(2%) patients, with extracapsular extension present in 6(5%) cases. Estrogen receptor, and HER2neu were positive in 116(90%) and 13(10%) patients, respectively. Oncotype Dx scores were low, intermediate, high or was not done in 34(26%), 21(16%), 6(5%), and 68(53%), respectively. Systemic treatment was delivered as chemotherapy, hormonal, and targeted therapy in 71(55%), 111(86%), and 9(7%), respectively.With a median follow up of 39 months, there were 2 (2%) LRF, 5 (4%) DM, and 4 (3%) deaths. On univariate analysis, no factors predicted for LRF, but MF and size predicted for DM and DFS (pConclusion: Locoregional control of N1mi disease was not affected by treatment modality. Larger tumors or MF have worse DM and DFS, and may benefit from systemic treatment intensification.

SSM21-02 Her-2 Positive is Associated with Increased Risk of Locoregional Recurrence of Breast Cancer Patients Treated with Neoadjuvant Chemotherapy and Breast Conserving Surgery

Wednesday, Nov. 29 3:10PM - 3:20PM Room: S105AB

Participants
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ABSTRACT

Purpose/Objective(s): Neoadjuvant chemotherapy (NAC) decreases tumor size and increase the chance of breast conserving surgery (BSC) for patients with large primary tumors. This study is to evaluate the outcomes of this group of patients and identify risk factors of locoregional recurrence (LRR) for further individualized treatment.Materials/Methods: A total of 108 breast cancer patients treated with NAC and BSC between 1999 and 2013 were retrospectively reviewed. There were 4 clinical stage I, 66 stage II and 38 stage III patients. After surgery, 103 (95.4%) had negative margins. 99 (91.7%) patients received adjuvant radiotherapy (RT) to the whole breast, with 41 patients received supraclavicular nodal RT simultaneously. Of patients with positive hormone receptor disease, 76 (88.4%) received endocrine therapy. Of patients with positive Her-2 disease, 16 (61.5%) received targeted therapy with trasuzumab. The rates of locoregional recurrence (LRR), distant metastasis (DM), disease-free survival (DFS) and overall survival (OS) were calculated using the Kaplan-Meier method, and differences were compared using the log-rank test.Results: The overall clinical response to NAC was achieved in 92 (85.2%) patients, with a complete response rate of 6.5% and a partial response rate of 78.7%. 32 (100%) patients with cT3-4 disease and 56 (84.8%) with cT2 achieved T-stage degradation. For 38 patients with clinical stage III, 30 (78.9%) was downstaged, and 8 (21.1%) achieved pathologic complete response (pCR). For 66 patients with clinical stage II, 30 (45.5%) was downstaged, and 8 (12.1%) achieved pCR. With a median follow-up time of 64 months, 12 patients had LRR, including 6 breast recurrence and 6 regional recurrences. Eighteen patients had DM. The 5-year rates of LRR, DM, DFS and OS for all patients were 11.0%, 15.1%, 77.9% and 97.0%, respectively. In univariate analysis, patients with Her-2 positive disease had higher LRR rate as compared with Her-2 negative (27.0% vs. 6.3%, P = 0.020), whereas there were no significant differences in LRR between clinical III and stage I-II (15.4% vs. 10.0%, P = 0.448) or between pathologic stage III and stage 0-II (10.8% vs. 11.1%, P = 0.518).Conclusion: BCS performed selectively after NAC for breast cancer patients is safe, and the LRR is acceptably low. Her-2 positive is associated with increased risk of LRR, although 61% Her-2 positive patients

received anti HER-2 targeted therapy. Further study is warranted to verify this finding.

SSM21-03 Interplay between AlignRT Tracking Accuracy and Breast Surface Topography

Wednesday, Nov. 29 3:20PM - 3:30PM Room: S105AB

Participants
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PURPOSE

AlignRT is a commercial 3D-optical surface imaging system specifically designed for radiation oncology applications. It is often used for chest surface motion tracking for the breast cancer patients treated with deep-inspiration breath-hold (DIBH) protocol. Since AlignRT tracking accuracy and reliability are highly ROI-dependant, a variation in breast topography could result in incorrect patient shifts. So far, no study has examined how AlignRT tracking accuracy is affected by changes in breast surface topography. The goal was to understand hidden interconnections and establish corresponding clinical guidelines.

METHOD AND MATERIALS

An anthropomorphic phantom and 8 breast phantoms of different shapes were used in this study.The diameters of the breast phantoms were 12.9, 15.0, 15.8, 16.0, 17.7, 21.5, and 28.0 cm with central elevations of 1.7, 5.4, 3.0, 3.8, 1.4, 0.9, and 1.5 cm. For each set of measurements, a breast phantom was attached to the anthropomorphic phantom. A reference surface image was acquired. To eliminate ROI-dependency effect, an identical ROI was used throughout the study. The couch was then manually shifted by -1.0, -2.0, 1.0, and 2.0 cm in VRT, LAT, and LNG directions sequentially. The AlignRT-measured shifts were obtained by acquiring a static treatment surface image and registering with the reference surface image.

RESULTS

We found that AlignRT tracking accuracy was not significantly affected by variations in breast topography as long as an ROI much larger than the breast was used. Breast tissue with higher elevations tended to yield better tracking results. A couch shift further away from isocenter tended to produce less accurate tracking results. The tracking uncertainties were found to be ~1.0 mm in translations and ~1.0° in rotations. These often occurred in LAT shift and yaw rotation.

CONCLUSION

For breast and chest wall applications, AlignRT tracking accuracy is independent of breast surface topography as long as a large ROI (covering the entire breast, SCV, axilla, sternum, and some lateral aspects of the chest) is used.

CLINICAL RELEVANCE/APPLICATION

AlignRT uses structured light to measure 3D surface of a cancer patient for pre-treatment setup and intra-fractional motion tracking.

SSM21-04 Analysis of Treatment Effectiveness and Complications Associated with Accelerated Partial Breast Brachytherapy in Patients Treated at a Single Institution

Wednesday, Nov. 29 3:30PM - 3:40PM Room: S105AB

Participants
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ABSTRACT

Purpose/Objective(s): MammoSite™ is a form of Accelerated Partial Breast Irradiation (APBI) designed to deliver targeted doses of radiation from within breast tumors. This method of radiation delivery allows higher doses of radiation, reduces treatment fractions, and aims to reduce toxicities from external beam radiation therapy. While the use of MammoSite™ has been well studied, the results from the only randomized control trial, RTOG 0413/NSABP B-39, are pending. We aim to present efficacy and toxicity data for follow-up of over five-years for patients receiving MammoSite™ at our institution. Materials/Methods: We performed a retrospective analysis of patients at a single institution who presented with early stage breast cancer and received breast conserving surgery. These patients elected to receive accelerated partial breast irradiation (APBI) using the MammoSite™ catheter device. Patients were treated with 30.6 - 34.0 Gy in 3.4 Gy fractions given twice daily with fractions at least six hours apart utilizing either a spherical or ellipsoidal catheter device. Patient data was collected regarding the specific treatment and planning

volumes, complications and toxicities occurring during and after treatment, and the overall outcome of each patient relating to tumor-free survival.Results: From October 2005 through November 2010, 78 patients with 79 lesions were treated with APBI using the MammoSite™ catheter device and were eligible for our retrospective analysis. Patients with less than 24 months follow up were excluded from the study. 79.5% of patients were ER positive, 55% were PR positive, and 17.9% were HER2/neu positive. Seven patients (9.0%) had N1 disease. The median follow-up time was 80 months. Of the patients in our study, there were a total of 10 recurrences (12.8%), with 5 local recurrences (6.4%), 2 local recurrences that developed into distant metastases (2.6%), and 3 distant metastases (3.8%). Two recurrences were considered new primary lesions due to receptor status change in the new tumor. Specific toxicities include 12 patients with skin erythema (15.4%), 7 patients with seroma (9%), 8 patients with localized edema (10.3%), and 6 patients with infection (7.7%).Conclusion: This case series of 78 patients with a median follow-up of 80 months, from a single institution, provides important data regarding failure analysis with MammoSite™ accelerated partial breast irradiation. Our results show a higher rate of metastatic recurrence in the group of patients with positive nodal disease as expected. Further prospective analysis, such as the B-39 trial, is required to fully assess the efficacy and safety of MammoSite™ in the treatment of cancer with APBI.

SSM21-05 Prospective Study of Accelerated Partial Breast Irradiation Using Three Dimensional-Conformal Radiotherapy for Early Stage Breast Cancer

Wednesday, Nov. 29 3:40PM - 3:50PM Room: S105AB

Participants
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ABSTRACT

Purpose/Objective(s): In Japan, only a few trials of accelerated partial breast irradiation (APBI) using three dimensional-conformal radiotherapy (3D-CRT) have been reported so far. The aim of this study is to evaluate the efficacy and safety of APBI using 3D-CRT for Japanese women.Materials/Methods: Eligibility criteria for this protocol included age=40 years old, no preoperative systemic treatment, stage Tis-2N0-1M0, negative surgical margins (>5 mm) following breast conserving surgery, and surgical clips intraoperatively placed at the cranial, caudal, medial, and lateral edge of the seroma cavity. For image-registration, the positions of the clips in daily kV x-ray images were matched to those in the planning digitally reconstructed radiographs. We adopted beam arrangements of four- or five- 6 MV X-ray noncoplanar fields with 5-mm multi-leaf collimator. The prescribed dose was 38.5 Gy in 10 fractions over 2 weeks. The toxicity grading was based on Common Toxicity Criteria for Adverse Events (CTCAE) v4.0.Results: Between January 2012 and June 2016, 50 patients with early stage breast cancer were enrolled for the trial of APBI using 3D-CRT following breast conserving surgery at Kyoto University Hospital. Since two of them were excluded because of the dose constraint of contralateral breast, we analyzed 48 patients who underwent APBI. All patients completed the radiation treatment. The median age was 57.5 years old (range, 42–81 years old). The disease was Stage 0 in 6 (13%), Stage IA in 34 (70%), Stage IIA in 8 (17%) patients. Seven patients received adjuvant chemotherapy, followed by APBI within 6 weeks after the end of chemotherapy. At the median follow-up of 31 months (range, 5.4–55 months), no locoregional recurrence or distant metastases of breast cancer were observed. Two-year overall survival was 100 %. Grade 2 adverse events were breast atrophy (4%), breast pain (2%), fibrosis (2%), dermatitis (2%), fever (2%), and pigmentation (2%). Grade 3 soft tissue cellulitis of the breast was observed in one patient. There was no grade 4-5 toxicity. Cosmesis outcomes by four point scale were excellent/good for 77% of patients at pretreatment state and for 63% at 1 year after APBI. The cosmesis scales were improved in 3 patients (6%), worsened in 7 patients (15%), and unchanged in the rest of the patients (79%) at 1 year after APBI.Conclusion: Two-year disease control treated with this APBI protocol using 3D-CRT for Japanese early-stage breast cancer patients was good, and the adverse events and cosmesis outcomes were feasible and satisfactory.

SSM21-06 Risk of Early Onset Breast Cancer among Women Exposed to Thoracic CT in Pregnancy or Early Postpartum

Wednesday, Nov. 29 3:50PM - 4:00PM Room: S105AB

Participants
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PURPOSE

The risk of breast cancer may be higher with direct exposure to ionizing radiation from thoracic computed tomography (CT) during pregnancy or postpartum, when breast tissue undergoes proliferation and differentiation.

METHOD AND MATERIALS

We completed a retrospective population-based cohort study. Universal health care databases in Ontario, Canada were used to identify deliveries between 1995-2014. The main exposure was thoracic CT in pregnancy or <= 42 days postpartum. Exposure to VQ scan was used as an active comparator, as there is no direct-beam radiation to the breast. Each was compared to pregnancies unexposed to thoracic CT or VQ scan. The primary study outcome was newly diagnosed breast cancer starting 366 days after the index delivery date.

RESULTS

5,859 pregnancies were exposed to thoracic CT, 97% of which had intravenous contrast; 4075 to VQ scan; and 1,292,059 to neither. After a mean (SD) duration of follow-up of 11.1 (5.7) years, a total of 10,129 women were diagnosed with breast cancer, of which 9,039 (89.2%) were aged <= 50 years. There were 27 new cases of breast cancer (7.1 per 10,000 person-years) following

thoracic CT vs. 10,080 (7.0 per 10,000 person-years) among the unexposed - an adjusted HR of 1.17 (95% CI 0.80-1.70). Following VQ scan exposure, the incidence rate of breast cancer was also 7.0 per 10,000 person-years - an adjusted HR of 1.23 (95% CI 0.81-1.87) compared to the unexposed cohort.

CONCLUSION

Exposure to thoracic CT during pregnancy or postpartum was not associated with an increased short-term risk of maternal breast cancer.

CLINICAL RELEVANCE/APPLICATION

Published recommendations about the safety of ionizing radiation in pregnancy and postpartum have typically focused on the potential teratogenic effects to the fetus, while mentioning the possibility of a higher risk of breast cancer. Although an increased risk of breast cancer following radiological ionizing radiation exposure during pregnancy or lactation has been postulated, this has never been quantified. The current findings help inform those guidelines.

SSM22

Vascular Interventional (Biopsy)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E352

IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Charles Martin III, MD, Pepper Pike, OH (*Moderator*) Scientific Advisory Board, Boston Scientific Corporation

Sub-Events

SSM22-01 Incidence of Bleeding Complications after Percutaneous Core Needle Biopsy and the Association with Aspirin Usage and Length of Aspirin Discontinuation

Wednesday, Nov. 29 3:00PM - 3:10PM Room: E352

Participants
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PURPOSE

To report rate of major bleeding complications after percutaneous image-guided core biopsy and to determine risk related to aspirin use and length of aspirin discontinuation prior to biopsy.

METHOD AND MATERIALS

Following IRB approval, we retrospectively reviewed a prospectively-maintained database for all percutaneous image-guided core biopsies performed at our institution between 9/1/2005 and 9/1/2016 (n=30,966). Patients were excluded if aspirin usage data was missing (n=633). Bleeding complications were defined using the Common Terminology Criteria for Adverse Events (CTCEA, version 3) established by the National Cancer Institute and were considered significant if grade 3 or higher. Multivariate models were adjusted for age, gender, platelet count, international normalized ratio (INR), and biopsy target. Three categorizations of aspirin use were examined: any use within 10 days prior, length of discontinuation (>10 days/no aspirin, 8-10, 4-7, and 0-3 days prior), and use on day of biopsy. Associations with bleeding complications were modeled using generalized estimating equations logistic regression models. P-values <=.05 were considered significant.

RESULTS

30,333 biopsies in 21,938 unique subjects were included (mean (SD) age 58 years (16), 57% male). 7,921 (26.1%) biopsies were performed in patients who received aspirin within 10 days of biopsy, 47.5% of which (3,761) took it within 3 days prior to biopsy. 98 significant bleeding complications (grade 3 or higher) occurred across all included cases (0.32%), 34 in those with aspirin use during the prior 10 days (0.43%), 22 within 0-3 days (0.58%), and 17 with aspirin use on same day as biopsy (1.9%). Aspirin use within 10 days of biopsy increased the bleeding risk, but not significantly (OR 1.5 [.96-2.3], p=.08). Days since discontinuation showed significant increase in bleeding only between 0-3 days versus >10 days/no aspirin groups (OR 2.1 [1.3-3.6], p=.004). Aspirin use on day of biopsy showed the greatest increase in risk (OR 6.6 [3.8-11.5], p<.001).

CONCLUSION

Major bleeding complications after percutaneous core biopsy are rare. Aspirin use within 3 days of biopsy is associated with increased risk of bleeding.

CLINICAL RELEVANCE/APPLICATION

A short period of aspirin cessation prior to biopsy may be sufficient to decrease risk of bleeding although risk remains low even in those with recent aspirin use.

SSM22-02 A Team-Science Approach to Support Personalized Cancer Care: Role and Value of Interventional Radiology in Clinical Trials

Wednesday, Nov. 29 3:10PM - 3:20PM Room: E352

Participants
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PURPOSE

Biopsy yield is critical for determining a patient's trial eligibility and treatment. We report our experience with supporting the BATTLE and BATTLE-2 lung cancer trials, focusing on the role of interventional radiologists (IRs).

METHOD AND MATERIALS

The medical records of patients who underwent percutaneous image-guided biopsy for the BATTLE and BATTLE-2 trials were reviewed. A radiology-based, 3-point, lesion scoring system was developed. Lesions were scored a 3 (most likely to yield sufficient material for biomarker analysis) if they met the following criteria: size $\geq$2 cm, solid mass, demonstrate imaging evidence of viability, and technically easy to sample. Lesions that did not meet all four criteria, were scored a 2 with the missing criteria noted as negative factors. The lesions biopsied were retrospectively scored by two IRs and univariate and multivariate analyses were performed to evaluate the score's ability to predict successful yield for biomarker adequacy.

RESULTS

A total of 555 biopsies were performed for BATTLE and BATTLE-2. Overall yield for analysis of the required biomarkers was 86.1% (478/555) and 84% (268/319) and 88.9% (210/236) for BATTLE and BATTLE-2, respectively (p=0.09). Lesions receiving a score of 3 were adequate for biomarker analysis in 89% of cases. Lesions receiving a score of 2 with more than one negative factor were adequate for biomarker analysis in 69.2% (p=0.03) and 74% (p=0.04) of cases when scored by IR1 and IR2, respectively. The kappa statistic between the two IRs scoring was 0.55 [95% CI: (0.48, 0.61)] indicating moderate agreement as lesions were scored the same by both IRs in 78.4% of cases.

CONCLUSION

A team-science approach can facilitate consistent yields for biomarker analysis in clinical trials. IRs play a critical role for lesion selection.

CLINICAL RELEVANCE/APPLICATION

By leveraging the expertise of the individual specialties (medical oncology, pathology, IR), achieving consistently high adequacy rates from image-guided biopsies for biomarker analysis is feasible.

SSM22-03 Causes of Inadequate Sampling in IR Biopsies: Review of 3256 Biopsies

Wednesday, Nov. 29 3:20PM - 3:30PM Room: E352

Participants
Peter T. Hoang, MD, Phoenix, AZ (*Presenter*) Nothing to Disclose
Andrew R. Fleck, MD, Phoenix, AZ (*Abstract Co-Author*) Nothing to Disclose
Alex L. Wallace, MD, Phoenix, AZ (*Abstract Co-Author*) Nothing to Disclose
Jeffry S. Kriegshauser, MD, Phoenix, AZ (*Abstract Co-Author*) Research support, General Electric Company
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PURPOSE

The role of the interventional radiologist in the Precision Medicine Initiative has become increasingly important in providing the necessary tissue for genetic analysis. However, inadequate sampling rate for DNA testing exceed 20% resulting in repeat biopsies and delays in treatment. The aim of this study was to evaluate variables that associate with inadequate biopsy sampling in a large tertiary medical center.

METHOD AND MATERIALS

This IRB approved, HIPAA compliant study involved a search of our radiology department database for biopsies performed from January 2015 to December 2015. 3256 biopsies were included in the study in which 104 biopsies were ordered for genetic testing. Electronic medical records including radiology and pathology reports were reviewed for lesion size, tissue type, biopsy equipment, aggregate core length, number of samples obtained and the operator experience. Statistical analysis was performed using univariate analysis and logistic regression.

RESULTS

Inadequate tissue sampling rate was 20.1% (21/104). Univariate analysis showed an association between inadequate samples and smaller needle gauge (p=0.02) and smaller core length (p=0.01). There was no association with lesion size (p=0.39) and operator

experience (p=0.8). In logistic regression, the inadequate sampling rate was not different when obtaining 2 or more samples or an aggregate core length of 1-2 cm (P=0.95 and p=0.73). Temno (BD) devices resulted in 31% inadequate sampling rate, Bard (CR Bard) in 8% and BioPince (Argon Medical) in 8%. Genetic testing led to appropriate selection of therapy in 80% of the patients with adequate sampling.

CONCLUSION

Smaller needle gauge and smaller core lengths were associated with higher inadequate sampling rates. There was no added benefit to obtaining more than 2 to 3 biopsy samples or more than 1 to 2 centimeters of aggregate core tissue length. Adequate tissue for DNA testing is critical; results show that they can guide selection of therapy.

CLINICAL RELEVANCE/APPLICATION

Adequate tissue for DNA testing is critical; it can guide selection of therapy.

SSM22-04 Freehand Ultrasound-Guided Targeted Transperineal Prostatic Biopsy Technique (FUGTTPB) for Suspicious Lesions Identified By Magnetic Resonance Imaging (MRI)

Wednesday, Nov. 29 3:30PM - 3:40PM Room: E352

Participants
Joel Lim, MBBS, Perth, Australia (*Presenter*) Nothing to Disclose
Tonya Halliday, MBChB, Glasgow, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Sally Burrows, Perth, Australia (*Abstract Co-Author*) Nothing to Disclose
Victoria Toal, Perth, Australia (*Abstract Co-Author*) Nothing to Disclose
Yuranga Weerakkody, MBBCh, Auckland, New Zealand (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

FUGTTPB has many advantages over the traditional transrectal ultrasound-guided technique including lower infection rates. This study aims to investigate the cancer detection rates of this novel technique by comparing Prostate Imaging Reporting and Data System Version 2 (PI-RADS) and Gleason scores.

METHOD AND MATERIALS

A retrospective cohort study was conducted of all men who underwent an MRI Prostate between January 2015 and December 2016 with a lesion graded as PI-RADS 3 or greater followed by FUGTTBP in our institution. These were performed in the outpatient setting with the index lesion targeted free hand without the use of a grid or image fusion, guided by transrectal ultrasound.

RESULTS

99 men (mean age 65 years) referred by 20 Urologists underwent MRI at 6 centres with 129 lesions identified. 75% were imaged based on clinical suspicion whilst 25% were followed for a previous prostatic malignancy. Cancer detection rates for PI-RADS 3, 4 and 5 lesions were 42% (95% CI 27.9 - 57.3), 63% (95% CI 46.9 - 75.9) and 97% (95% CI 77.5 - 99.6) respectively. The PI-RADS 3 and 5 rates are comparable to the only published study comparing PI-RADS Version 2 and Gleason scores. The PI-RADS 4 rate was slightly lower but this may be attributed to the varying experience of the 13 MRI reporters and 4 patients having PI-RADS 4 lesions which were non-index lesions as they also had PI-RADS 5 lesions. 3 patients had positive cores beyond the target area but these were not identified as suspicious on MRI. Only 1 core from each patient was positive and all were graded as Gleason 6 with tumour lengths of 1 mm or less.

CONCLUSION

This pilot study demonstrates promising cancer detection rates of the FUGTTPB technique especially for higher grade PI-RADS lesions. However, it is limited by MRI sensitivity as 3 patients had tiny positive cores outside of the target area. Given the numerous benefits, further evaluation of this technique may result in evolution of prostatic biopsy techniques.

CLINICAL RELEVANCE/APPLICATION

MRI has shown promise in identifying clinically significant prostatic tumours. Targeting these via the FUGTTPB technique has numerous benefits.

SSM22-05 Preliminary Study to Compare the Effectiveness of Four Hemostatic Methods: Locally Injected FFP, Systemic FFP, Local Gelfoam Insertion, or Local Coil Insertion for Preventing Bleeding Complications

Wednesday, Nov. 29 3:40PM - 3:50PM Room: E352

Participants
John R. Haaga, MD, Cleveland, OH (*Presenter*) Nothing to Disclose
Jon Davidson, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Shiraz Rahim, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Indravadan J. Patel, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Dean A. Nakamoto, MD, Beachwood, OH (*Abstract Co-Author*) Research agreement, Toshiba Medical Systems Corporation
Nami R. Azar, MD, Highland Heights, OH (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess the efficacy of local hemostatic techniques in coagulopathic patients with abnormal INR. These techniques included: 1) local injection of fresh frozen plasma 2)systemic administration of fresh frozen plasma 3)local insertion of gelfom 4)local insertion of

angiographic coils into intervention site.

METHOD AND MATERIALS

Data was collected from 4 IRB approved studies totaling 182 patients. Procedures and biopsies included 80 liver biopsies, 35 abscess drainages, 21 soft tissue masses, 18 kidney biopsies, 7 cholecystostomies, and 13 chest tubes. Causes of the coagulopathy included anticoagulation treatment, liver failure, hematologic malignancy, chemotherapy, and idiopathic.The most common causes were coumadin and liver failure in 118 patients. INR ranges for each group were: 91 patients treated with local injection of FFP (INR1.4-3.0, avg 2.1), 40 patients treated with gelfoam (INR 2.1-2.9, avg 2.32) , 35 patients with systemic FFP (INR 1.4-3.4, avg 2.1) , and 16 patients treated with angiographic coils (INR avg1.3).. Average amount of FFP used was 20 cc injected locally and 5.2 units intravenously. Average of 2 coils were used per patient. .

RESULTS

Bleeding complications were: drop in hemoglobin, visible hematoma, required transfusion, or intervention.Total//significant bleeding complications were 0//0% for locally injection of FFP, 17.1//2.8% for systemic FFP, 12.5//0% for gelfoam, and 37//12.5% for coils. 6 nonbleeding complications occurred in systemic FFP group and included shortness of breath, shortness of breath requring intubation (systemic group), 1 infection and death in 3 (2 volume overload, 1 idiosyncratic).

CONCLUSION

Of these methods used for hemostasis, local injection of FFP was the most effective, followed by gelfoam, systemic FFP, and local coils.These data provide a basis for organizing a larger prospective, randomized multiinstitutional study to confirm these findings and to study the cost benefit of the FFP groups.

CLINICAL RELEVANCE/APPLICATION

Percutaneous techniques play a major role for diagnoses and treatments. While normal patients have a low complication risk, coagulopathic patients are at greater risk of bleeding. Our comparison of different hemostatic methods provides preliminary data that the new 'local injection of blood products' technique is superior to other methods studied. Before this new method can be used widely, more data needs to be collected from large randomized, prospective studies.

SSM22-06 Percutaneous Hepatic Fiducial Gold Marker Implantation for Real-time Tumor-tracking Radiotherapy

Wednesday, Nov. 29 3:50PM - 4:00PM Room: E352

Participants
Ryo Morita, MD, Sapporo, Japan (*Presenter*) Nothing to Disclose
Yusuke Sakuhara, MD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose
Takeshi Soyama, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose
Daisuke Abo, MD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose
Kohsuke Kudo, MD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose
Norio Katoh, MD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose
Hiroki Shirato, MD, PhD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The purpose of this study was to evaluate the safety and complications associated with percutaneous fiducial global gold marker implantation into the liver parenchyma for real-time tumor-tracking radiotherapy (RTRT).

METHOD AND MATERIALS

This retrospective study was approved by our institutional review board. Using a medical record and database review, we evaluated data from 100 patients with hepatobiliary malignancies who underwent 116 percutaneous fiducial gold marker implantations in the liver as preparation for RTRT from 1999 to 2016. We used global markers that were 2 mm in diameter. All marker implantations were performed using Seldinger's method. Technical success was defined as completion of gold marker placement at the intended liver parenchyma. Clinical success was defined as successful tracking of the gold marker and completion of planned RTRT. In addition, we assessed complications related to the marker placement.

RESULTS

The technical success rate for fiducial gold marker implantation was 90% (104/116). Twelve of 116 markers could not be used for RTRT because of marker migration after implantation (n=9) or inappropriate location of the implanted marker (n=3). In 9 patients, markers migrated out of the liver; however, no complications occurred from not retrieving them. The clinical success rate was 99% (114/115), and we used another marker and completed RTRT for 1 tumor. Pain occurred in 16 patients, fever in 7, hemorrhage in 7, pneumothorax in 1, and nausea in 1. No major complications occurred.

CONCLUSION

Percutaneous fiducial gold marker implantation into the liver for RTRT is a safe and feasible procedure.

CLINICAL RELEVANCE/APPLICATION

Percutaneous fiducial global gold marker implantation into the liver for image-guided radiotherapy is safe and feasible. Physicians should monitor patients for migration of the implanted marker.

SSM23

Vascular Interventional (Bone/ST Intervention)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450B

IR MK VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: .50

Participants
Gordon McLennan, MD, Chagrin Falls, OH (*Moderator*) Research Grant, Siemens AG; Research Consultant, Medtronic plc; Advisory Board, Siemens AG; Advisory Board, Surefire Medical, Inc; Advisory Board, Stealth Medical; Advisory Board, Rene Medical; Data Safety Monitoring Board, B. Braun Melsungen AG
Charles Martin III, MD, Pepper Pike, OH (*Moderator*) Scientific Advisory Board, Boston Scientific Corporation

Sub-Events

SSM23-01 Has Gender Diversity Improved Among Interventional Radiology Fellows From 1991 to 2015? A Comparative Study With Other Related Fields

Wednesday, Nov. 29 3:00PM - 3:10PM Room: E450B

Participants
Paul H. Yi, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
William Barge, Peoria, IL (*Abstract Co-Author*) Nothing to Disclose
Douglas B. Yim, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose
Kelvin K. Hong, MD, Baltimore, MD (*Abstract Co-Author*) Scientific Advisory Board, Boston Scientific Corporation; Scientific Advisory Board, BTG International Ltd; Research support, Merit Medical Systems, Inc;

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PURPOSE

Although prior studies have shown a significant increase in women in most medical specialties over the past several decades, Interventional Radiology (IR) has traditionally been a male-predominate field and it remains unknown if gender diversity in IR has improved over time. The purpose of this study was to analyze trends in gender diversity in IR in comparison with other related fields over the past 25 years.

METHOD AND MATERIALS

We reviewed data from the American Association of Medical Colleges reported in annual issues on medical education in the Journal of the American Medical Association for the years 1991-2015. We assessed the percentages of women resident and/or fellows in IR fellowships and other related training programs, including Diagnostic Radiology residency, Endovascular Neuroradiology fellowship, Radiation Oncology residency, as well of Medical Students and Residents from all specialties. Changes in the percentages of females from 1991 to 2015 were calculated for each group using Chi-Square tests and Pearson's Correlation Coefficient, as appropriate; statistical significance was set at $p<0.05$.

RESULTS

From 1991 to 2015, the percentage of females in IR fellowship increased from 0% to 23% ($r=0.72$; $p<0.0001$). Similarly, from 1991 and 2015, the percentage of females in medical school and in residency (all specialties) improved from 38% to 47% ($p<0.001$) and 30% to 46% ($p<0.001$), respectively. In 2015, IR had the lowest percentage of females at 9.3% compared to 47% of medical students, 46% of all residents, 29% of radiation oncology, and 27% of diagnostic radiology ($p<0.001$ for all).

CONCLUSION

Although the percentage of women trainees in IR fellowship has significantly increased over the past 25 years, IR is lagging behind other related fields and the general medical student and trainee population in terms of gender diversity. We recommend increased recruitment efforts towards women at different levels of training both during and after medical school to recruit more women into the field of IR.

CLINICAL RELEVANCE/APPLICATION

IR has the lowest representation of women among related specialties. We recommend increased recruitment efforts towards women at different levels of training to help improve gender diversity in IR.

SSM23-02 Percutaneous Vertebroplasty in Aged Patients with Osteoporotic Vertebral Compression Fractures: A Bicentric Retrospective Cohort Study

Wednesday, Nov. 29 3:10PM - 3:20PM Room: E450B

Awards
Trainee Research Prize - Medical Student

Participants
Binyan Zhong, MD, PhD, Nanjing, China (*Presenter*) Nothing to Disclose
Gao-Jun Teng, MD, Nanjing, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

We aim to evaluate the effectiveness and safety of Percutaneous Vertebroplasty (PVP) in patients aged 80 and over with osteoporotic vertebral compression fractures (OVCFs) in two hospitals.

METHOD AND MATERIALS

Patients underwent their first PVP due to OVCFs between January 2006 and December 2014 in two large academic centers were selected to this bicentric retrospective cohort study. Patients were divided into two groups by age (aged 80 or older and no older than 80). The primary outcome of this study was pain relief at 1month and 1 year measured by visual analogue scale (VAS) score. Complications, including new vertebral compression fractures (VCFs) were recorded during the follow-up.

RESULTS

A total of 699 patients (382 in Hospital A and 317 in Hospital B) were included in this study and 139 (19.9%) of them were aged 80 or older. Chi-square test or one-way ANOVA showed that there was no statistical difference of the parameters about the patients between the two hospitals. For the aged patients, mean VAS score decreased from 6.9(95% CI 6.8-7.1) at baseline to 2.3(2.2-2.5) at 1 month ($P<0.0001$) and 1.8(1.7-1.9) at 1 year ($P<0.0001$). Compared to the patients no older than 80, there was no statistical difference of the VAS score. During the median follow-up of 1136 (range 5-2924) days, 40 (28.8%) patients had new VCFs with a median time of 80 (range 5-1022) days. No major complication occurred.

CONCLUSION

PVP is an effective and safe approach for the patients aged 80 or older with OVCFs.

CLINICAL RELEVANCE/APPLICATION

PVP should be regarded as a safe and effective treatment approach for patients aged 80 or older with OVCFs.

SSM23-03 Human Observer Detection Performance of Moving Objects in Fluoroscopic Image Series

Wednesday, Nov. 29 3:20PM - 3:30PM Room: E450B

Participants
Taylor Richards, Durham, NC (*Presenter*) Nothing to Disclose
Steve D. Mann, PhD, Durham, NC (*Abstract Co-Author*) Nothing to Disclose
Ehsan Samei, PhD, Durham, NC (*Abstract Co-Author*) Research Grant, General Electric Company; ; Research Grant, Siemens AG; ; Advisory Board, medInt Holdings, LLC

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PURPOSE

Evaluate human observer detection performance of moving objects in fluoroscopic image series as a function of object velocity and x-ray pulse-width.

METHOD AND MATERIALS

Simulated fluoroscopic image series of a translating wire (1 mm diameter, 30 mm length) in white Gaussian noise were presented to seven trained readers using a 4-alternative forced choice study paradigm. Image series were simulated at eight frames-per-second (8 fps), two wire velocities (10 mm/s, 25 mm/s) and two x-ray pulse-widths (4 ms, 120 ms). Object contrast and image spatiotemporal noise power were held constant for all image series.Each reader was trained to maintain a constant viewing position (50 cm) and to utilize a template image sequence to inform eye-tracking. A total of 200 image series, 50 series for each pulse-width velocity combination, were reviewed by every reader. Their task was to select the image sequence which contained the translating wire.Binary response data from all readers was analyzed using a generalized linear mixed effects model with a probit link function. The model included pulse-width and velocity as fixed effects, and an intercept reader random effect.

RESULTS

Average observer detection performance ranged from 48% correct at the longest pulse-width and fastest velocity (120 ms, 25 mm/s) to 89% at the shortest pulse-width and slowest velocity (4 ms, 10 mm/s). X-ray pulse-width and object velocity were significant predictors of human detection performance (p-value << 0.0001) with an estimated effect size of -0.96 (95% CI: -1.12, -0.79) and -0.90 (95% CI: -1.17, -0.65) respectively. The standard deviation of the reader random effect was estimated at 0.57. The reader random effect can be largely attributed to the fact that one reader group observed each case for double the amount of time (17.7 seconds) as the other reader group (8.7 seconds) and thereby increased average detection performance by 28% correct.

CONCLUSION

Human detection performance of moving objects in fluoroscopic image series decreased significantly and independently with increased velocity and increased pulse-width. Average observation time also effected detection performance.

CLINICAL RELEVANCE/APPLICATION

The use of fluoroscopic imaging for diagnostic and interventional tasks involving substantial anatomic motion may be optimized for detection performance by appropriate x-ray pulse-width selection.

SSM23-04 Academic Interventional Radiology Section Chiefs and the Physician Open Payments Program: Do

General Payments Correlate with Academic Productivity?

Wednesday, Nov. 29 3:30PM - 3:40PM Room: E450B

Awards
Student Travel Stipend Award

Participants
Derek T. Kim, Port Jefferson, NY (*Presenter*) Nothing to Disclose
Amanjit S. Baadh, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Abieyuwa Eweka, MD, Mineola, NY (*Abstract Co-Author*) Nothing to Disclose
Rose Calixte, PhD, Mineola, NY (*Abstract Co-Author*) Nothing to Disclose
Jason C. Hoffmann, MD, Mineola, NY (*Abstract Co-Author*) Consultant, Merit Medical Systems, Inc; Speakers Bureau, Merit Medical Systems, Inc

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PURPOSE

While the intent of the Physician Open Payments Program (OPP) reportedly is to increase transparency, the public receives minimal information about what these payments may entail, and patients may assume these are inappropriate or signify bias. To our knowledge, no analysis of payments in relation to academic productivity exists in the literature. Therefore, our goal was to study this relationship among interventional radiology (IR) chiefs at U.S. academic institutions.

METHOD AND MATERIALS

Per institution guidelines, IRB approval was not needed as the project used only publicly available information. A list of IR section chiefs at academic institutions with IR fellowships was created. All non-royalty general payments (NRGP) made to IRs in 2015 was downloaded from the OPP website. Pubmed search was used to correlate this with the academic productivity of each IR chief. Spearman correlation was used to measure the association between productivity and payment. Fisher's Z transformation was used to compute the 95% confidence interval for the correlation as a measurement of the strength of the association. In addition, 2015 payments to IR division chiefs were compared to 2015 payments to IR non-chiefs.

RESULTS

Out of 95 U.S. hospitals with an IR fellowship, 89 chiefs were identified. In 2015, 77 IR chiefs received at least one NRGP, averaging $9,911.88±23,183.91 (median $1628.97). In 2015, 1723 non-chief IRs received at least one NRGP, averaging $3,112.10±16,244.24 (median $243.79). A test of normality of the IR chiefs' NRGP and Pubmed publications revealed that both variables significantly deviate from normal distribution. Thus, the Spearman correlation coefficient is the appropriate measure of their association. Correlation between IR chiefs' productivity and payment is 0.44 with a 95% confidence interval of 0.24-0.59, representing a weak to moderate positive association.

CONCLUSION

A positive association exists between payment amount reported in the OPP system and academic productivity amongst IR section chiefs at academic U.S. institutions in 2015. The median IR chief 2015 NRGP was 668% higher than for non-chief IRs.

CLINICAL RELEVANCE/APPLICATION

The general public should be informed that IR chief payments and relationships with industry may have a link to academic productivity. The greater NRGP for academic IR chiefs may reflect a greater responsibility to interact with industry.

SSM23-05 How Comprehensive are Interventional Radiology Residency Websites?

Wednesday, Nov. 29 3:40PM - 3:50PM Room: E450B

Awards
Student Travel Stipend Award

Participants
Paul H. Yi, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
Sherwin Novin, Madison, WI (*Abstract Co-Author*) Nothing to Disclose
Taylor L. Vanderplas, Madison, WI (*Abstract Co-Author*) Nothing to Disclose
Douglas B. Yim, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose
Kelvin K. Hong, MD, Baltimore, MD (*Abstract Co-Author*) Scientific Advisory Board, Boston Scientific Corporation; Scientific Advisory Board, BTG International Ltd; Research support, Merit Medical Systems, Inc;

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PURPOSE

Interventional Radiology (IR) residency began its first application cycle this past year. As the majority of residency applicants turn to the Internet to evaluate potential residency programs, maintaining a comprehensive website is crucial for attracting the best and brightest medical students. The purpose of this study was to evaluate the comprehensiveness of IR residency websites during the first application cycle.

METHOD AND MATERIALS

We searched all integrated IR residency programs listed on the Society for Interventional Radiology website for the presence of a dedicated residency website. For programs with a dedicated website, we searched for the presence of 38 criteria previously identified as important considerations for medical students applying to Radiology residency (Image 1). We compared prevalence of these criteria between different regions of the country and size of residency program using T-tests and ANOVA.

RESULTS

Of 61 IR residency programs identified, 44 (72%) had dedicated websites. Of these 44, only 1 program had at least 2/3 of criteria assessed and only 10 programs (23%) had half or more. On average, the websites reported 37% of items evaluated. The most frequently included information was contact e-mail (93%), mailing address (89%), resident social life (64%) and the area surrounding each residency (61%). The least commonly included information was about procedure simulation experience (5%) and description of teaching didactics (5%). There was no significant difference in website comprehensiveness between regions (p = 0.49), or between "large" programs (3+ residents/year) and "small" programs (>3 residents/year) [P = 0.36].

CONCLUSION

Nearly one-third of integrated IR residency programs do not have a dedicated website, and those that do exist are inadequately comprehensive, with less than 40% of assessed criteria present. Contact information and information about life outside of work were the most commonly included information with comparatively less frequent description of the clinical training opportunities. Addressing these gaps in website content will help IR residencies better inform prospective applicants and, in turn, help recruit the best and brightest into the field.

CLINICAL RELEVANCE/APPLICATION

Ensuring comprehensive interventional radiology residency program websites will help recruit the best and brightest medical students into the field.

SSM23-06 Comparative Utilization of Carotid Stenting and Carotid Endarterectomy in the Medicare Population in Recent Years

Wednesday, Nov. 29 3:50PM - 4:00PM Room: E450B

Participants
Sarah I. Kamel, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
David C. Levin, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Laurence Parker, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Vijay M. Rao, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

In the late 1990s, multiple controlled trials demonstrated that carotid endarterectomy (CEA) is superior to optimal medical therapy for stroke prevention, particularly in patients with high grade symptomatic stenosis. CEA is preferred to carotid artery stenting (CAS) given that the perioperative risk of stroke or death can be up to two fold higher with CAS. Our purpose was to study the recent trends of CEA and CAS in the Medicare population in response to the literature.

METHOD AND MATERIALS

The nationwide Medicare Part B fee-for-service databases for 2003-2015 were used. We selected CPT codes 35301 (thromboendarterectomy, carotid) and 37215 (intravascular stent placement, cervical carotid). The databases indicate procedure volume for each code, which were used to calculate utilization rates per 100,000 Medicare beneficiaries. Medicare specialty codes indicated the specialty of the performing physician.

RESULTS

Utilization rate of carotid endarterectomy was at its highest in 2003 at 355 per 100,000 and has declined steadily to 156 in 2015 (-56%). A CPT code for CAS first became available in 2005. CAS utilization peaked in 2006 at 28, ranged between 25-26 studies from 2007 to 2011 and then declined to 16 by 2015 (-43% compared with peak) In 2015, the percent share of carotid stenting by specialty was: cardiology 45%, vascular surgery 20%, radiology 14%, neurosurgery 8%, neurology 6%, other 6%.

CONCLUSION

Since CEA has been demonstrated to have lower perioperative mortality compared to CAS, it is not surprising that CEA was performed nearly ten times as often in 2015. Considering the proven efficacy of CEA, it is surprising that its utilization rate has dropped 56% since 2003 and that in recent years, CAS use has also declined. Perhaps this decrease in intervention is due to improved efficacy of medical management of atherosclerosis in addition to stricter guidelines defining patients who would most benefit from carotid intervention.

CLINICAL RELEVANCE/APPLICATION

The utilization of both CEA and CAS is declining.

SSQ01

Breast Imaging (MRI Diagnostics)

Thursday, Nov. 30 10:30AM - 12:00PM Room: E450A

BR MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Wendy B. Demartini, MD, Stanford, CA (*Moderator*) Nothing to Disclose
Bonnie N. Joe, MD, PhD, San Francisco, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSQ01-01 Prospective and Randomized Intra-individual Comparison of Gadoterate Meglumine versus Gadobenate Dimeglumine at 3 Tesla: Evaluation with a Reduced Dose of Gadobenate Dimeglumine

Thursday, Nov. 30 10:30AM - 10:40AM Room: E450A

Participants
Paola Clauser, MD, Vienna, Austria (*Presenter*) Nothing to Disclose
Thomas H. Helbich, MD, Vienna, Austria (*Abstract Co-Author*) Research Grant, Medicor, Inc Research Grant, Siemens AG Research Grant, C. R. Bard, Inc
Claudio Spick, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose
Panagiotis Kapetas, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose
Maria Bernathova, MD, Wien, Austria (*Abstract Co-Author*) Nothing to Disclose
Pascal A. Baltzer, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To compare a standard dose of Gadoterate Meglumine (Gd-DOTA 0.15 mmol/kg) to a half dose of a high relaxivity contrast agent (Gabobenate Dimeglumine, Gd-BOPTA 0.075 mmol/kg) for breast lesion detection and characterization at 3 Tesla.

METHOD AND MATERIALS

Eligible for this IRB-approved prospective, randomized, intra-individual comparison study were patients with suspicious findings (BI-RADS 4 or 5) on conventional breast imaging (i.e. mammography, tomosynthesis or ultrasound) undergoing additional 3T MR imaging of the breast including high spatiotemporal resolution DCE (TWIST), T2w-TSE and DWI according to international recommendations. Two repeated, identical examinations at least 24h apart from each other were performed with both contrast agents being administered in a randomized order. Histology was defined as standard of reference. Three blinded breast radiologists, not affiliated with the site of enrollment, evaluated the examinations off-site. Lesion detection rate, sensitivity, specificity and accuracy were calculated per-lesion and per-region, and compared using the McNemar test. Multivariate analysis was used to control for inter-reader performance.

RESULTS

109 patients were prospectively recruited. Excluded were 5 patients due to technical problems or lack of reference standard. Finally, 104 women with 142 histologically verified breast lesions (109 malignant and 33 benign) were enrolled. Detection rate with Gd-BOPTA (84.5-88.7%) was not inferior to Gd-DOTA (84.5%-90.8%), P>0.165. In the per-region analysis, Gd-BOPTA had a significantly higher specificity (96.4%-98.7% vs 92.6-97.3%) and accuracy (96.3-97.8% vs 93.6-96.1%) as compared to Gd-DOTA for all three readers. Multivariate analysis demonstrated a reader-independent superior accuracy with Gd-BOPTA.

CONCLUSION

A reduced dose of Gd-BOPTA 0.075 mmol/kg is not inferior to a standard dose of Gd-DOTA 0.15 mmol/kg in breast lesion detection, and superior in lesion characterization at 3T breast MRI.

CLINICAL RELEVANCE/APPLICATION

A reduced dose of Gd-BOPTA (0.075 mmol/kg) achieves breast MRI lesion detection comparable to a standard dose of Gd-DOTA, with a superior diagnostic performance. A reduced dose of Gd-BOPTA can be safely used in clinical practice at 3T breast MRI.

SSQ01-02 American College of Radiology Imaging Network (ACRIN) 6702 Diffusion-Weighted Breast MRI Trial: Image Quality and Factors Associated with Lesion Evaluability

Thursday, Nov. 30 10:40AM - 10:50AM Room: E450A

Participants
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PURPOSE

Diffusion-weighted imaging (DWI) has potential to improve conventional breast MRI specificity. Most DWI sequences use a single-shot echo planar imaging-based readout, which is prone to artifacts that may limit breast DWI reliability. The ACRIN 6702 multisite trial investigated DWI performance for diagnosing breast lesions. Here we describe DWI quality and factors affecting evaluability of apparent diffusion coefficient (ADC) values in breast lesions in the trial.

METHOD AND MATERIALS

The IRB-approved trial was performed at ten institutions on multiple 1.5T and 3T MRI platforms (Philips, GE, and Siemens). Women with MRI-detected BI-RADS 3, 4, or 5 lesions were enrolled in the study (from 3/2014 to 4/2015). Multi b-value (0, 100, 600, 800 s/mm2) DWI was performed in clinical breast MR exams. Each DWI scan was reviewed for image quality factors: fat suppression, signal-to-noise ratio (SNR), artifacts (magnetic susceptibility distortion, aliasing, chemical shift), and misregistration (from eddy-current-induced distortion). Lesions were considered not evaluable if significant image quality factors and/or lack of lesion visibility (due to partial volume averaging) prevented ADC measurement. Associations between image quality factors, field strength, lesion type (mass vs. non-mass), size, and evaluability were explored by Fisher's exact test.

RESULTS

ACRIN 6702 included 103 women with 142 lesions, of which 42 (41%) exams were performed at 1.5T and 61 (59%) at 3T. Poor or incomplete fat suppression affected 21% (22/103) of DWI scans, poor SNR 20% (21/103), artifacts 31% (32/103), and misregistration 20% (21/103). Exams at 1.5T were more prone to misregistration ($p=0.002$), while 3T exams exhibited more aliasing artifacts ($p=0.003$). ADC was evaluable for 100/142 (70%) lesions; factors associated with non-evaluability ($p<0.05$) included poor SNR, misregistration, and small lesion size <10mm (most common factor), but not lesion type or magnetic field strength.

CONCLUSION

This multisite breast DWI trial shows image quality remains a challenge, precluding measurement of 30% of lesions. Protocol optimization and technical advancements are needed to improve reliability and potential for widespread clinical implementation.

CLINICAL RELEVANCE/APPLICATION

Given strong data from this ACRIN 6702 trial that DWI can reduce false-positive breast MRIs, further research investment to improve image quality is warranted to facilitate clinical translation.

SSQ01-03 Contralateral Parenchymal Enhancement on Dynamic Contrast-Enhanced MRI is Complemented by Genomic ER-Pathway Data in Stratifying Outcome of ER+HER2 - Breast Cancer Patients

Thursday, Nov. 30 10:50AM - 11:00AM Room: E450A

Participants
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PURPOSE

High contralateral parenchymal enhancement (CPE) on dynamic contrast-enhanced MRI in the healthy breast of patients with ER+HER2- breast cancer receiving hormonal therapy has been associated with superior overall survival (OS). For patients with intermediate CPE, results have been inconclusive. The purpose of this retrospective study was to explore whether estrogen receptor (ER)-pathway activity derived from genomic data of the primary tumor is able to complement CPE in patient risk stratification.

METHOD AND MATERIALS

Between 2000 and 2008, 415 patients with ER+HER2- breast cancer eligible for breast-conserving therapy based on conventional imaging and physical examination received a preoperative MRI in study context. 181 Patients received hormonal therapy. Fresh-frozen tumor tissue of 104 patients was available for RNA sequencing. CPE was calculated using previously reported method. In short, parenchyma was automatically segmented, after which CPE was calculated as the mean of the top-10% relative signal increase. The ER-pathway activity of the tumor was assessed using unsupervised clustering of RNA, protein, and DNA copy number data from the TCGA database [Bismeijer et al.], and re-applied on the current dataset. The assay is strongly associated with activation of ESR1 targets. CPE and ER-pathway were each split in three groups (high, intermediate, low). OS was analyzed using Cox's models between CPE groups, ER-pathway groups, and combinations thereof.

RESULTS

The average patient age was 57 years (range: 32-84). The median follow-up was 87 months (range: 34-146). An event occurred in

11/104 (11%) patients. Patients with high CPE (n=38, 1 event) showed superior OS compared to those with low CPE (n=31, 7 event, P=.043), while for intermediate CPE (n=35, 33%) the test was inconclusive (P=.13). Differences in OS were observed between high and low ER-pathway, although not significant (P=0.12). When combined, patients with low CPE and low ER-pathway activity (n=52, 10 events) showed significantly worse survival than other patients (n=52, 1 event, P=.027).

CONCLUSION

CPE appears to be complemented by genomic-derived ER-pathway activity in stratifying patient survival.

CLINICAL RELEVANCE/APPLICATION

Combination of preoperative parenchymal enhancement on MRI of the healthy breast and ER-pathway axtivity in the primary tumor may predict therapy outcome more efficiently than either one alone.

SSQ01-04 Quantitative Measurement of Background Parenchymal Enhancement in Postmenopausal Women

Thursday, Nov. 30 11:00AM - 11:10AM Room: E450A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To investigate MRI contrast material-enhancement kinetics of breast background parenchyma (BPE) in postmenopausal women with benign and malignant lesions using a semiautomatic method of segmenting fibroglandular tissue for quantitative measurement.

METHOD AND MATERIALS

The institutional review board approved this retrospective HIPAA-compliant study, and informed consent was waived. From January 1, 2013 to December 31, 2013, 83 postmenopausal women who had undergone contrast-enhanced MRI at 3T (90 s/frame) were identified. BPE in 53 malignant cases (age 61.57±8.39; range 50-83) and 30 benign cases (age 60.43±7.60; range 50-76) were analyzed. A method based on principal component analysis (PCA) was used to semi-automatically segment the fibroglandular tissues. The primary eigen component was used for quantitative analysis of signal enhancement in the breast parenchyma in terms of the percentage of enhancement (PE) for the initial (90 s) and delayed (360 s) post-contrast time points. Lesion-PE was measured using manually drawn regions of interest. Statistical analyses were performed using the Mann-Whitney U test.

RESULTS

53 malignant cases, of which 37 were invasive ductal carcinoma (IDC), 11 invasive lobular carcinoma (ILC), and 5 other invasive malignancies, were identified. 30 benign cases of which 11 were fibrocystic changes, 11 stable findings on imaging, and 8 others, were identified. There was no statistical difference in age and lesion size among these 3 groups. No statistical difference existed between initial and delayed BPE-PE in malignant cases compared to benign cases (p=0.051; p=0.09). In women with ILC, the initial and delayed BPE-PE values were significantly higher than in women with IDC (p=0.022 and p=0.02, respectively) and in women with benign lesions (p=0.006 and p=0.01, respectively). Lesion-PEs were not significantly different between IDC and ILC cases.

CONCLUSION

Higher BPE-PEs were seen in cases with malignant lesions compared to those with benign lesions. The sub-group analysis showed that cases with ILC have higher BPE-PE than those with IDC and with benign lesions.

CLINICAL RELEVANCE/APPLICATION

Significantly increased BPE in postmenopausal ILC cases, compared to IDC and benign cases, may be associated with ILC development in the absence of progesterone after menopause.

SSQ01-05 Impact of a Novel Abbreviated Breast MRI Protocol on Kinetic Analysis of Benign and Malignant Lesions

Thursday, Nov. 30 11:10AM - 11:20AM Room: E450A

Participants
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PURPOSE

To compare kinetic analyses and discrimination of benign and malignant lesions based on a novel abbreviated breast MRI (AB-MRI) versus a traditional extended dynamic contrast-enhanced MRI (DCE-MRI) protocol.

METHOD AND MATERIALS

This IRB-approved retrospective study included 162 patients with 177 lesions (84 imaged with AB-MRI and 93 imaged with DCE-MRI) assessed as BI-RADS category 4, 5, and 6 between 10/1/2015-8/31/2016. Traditional DCE-MRI included one pre and three post-

contrast phases: initial phase at 60-75 seconds and the third phase at 420-450 seconds post contrast (45 minutes total scan time). AB-MRI included one pre and two post-contrast phases: initial phase at 60-75 seconds and the second phase at 180-205 seconds post contrast (<10 minutes total scan time). Computer-aided kinetic analyses of lesions included delayed-phase volume percentages of washout, predominant curve type, and worst curve type, which were compared using Wilcoxon rank-sum test and Chi-Square test. Receiver operating curve (ROC) analyses for discrimination of benign and malignant lesions were performed.

RESULTS

The AB-MRI group consisted of 21 benign, 2 high risk, and 61 malignant lesions; the traditional DCE-MRI group consisted of 19 benign, 8 high risk, and 66 malignant lesions. Mean delayed-phase percentages of washout were 8% [range 0-45%] versus 9% [range 0-62%] (p=0.36) for benign lesions and 19% [range 0-92%] versus 17% [range 0-71%] (p=0.66) for malignancies in the AB-MRI and DCE-MRI groups respectively. No significant differences were found in the predominant and worst curve types for malignant and benign lesions between protocols (p>0.05). There were no significant differences between the AB-MRI and DCE-MRI in areas under the ROC curves (AUC) for delayed-phase percent washout (AUC 0.67 vs. 0.69, p=0.81), predominant curve type (AUC 0.62 vs. 0.55, p=0.45), or worst curve type (AUC 0.50 vs. 0.56, p=0.53).

CONCLUSION

Our study suggests that our novel AB-MRI protocol does not negatively impact the kinetic analyses and discrimination of benign and malignant lesions compared to traditional DCE-MRI, with malignant lesions demonstrating higher percentages of washout than benign lesions with both protocols.

CLINICAL RELEVANCE/APPLICATION

Abbreviated breast MRI protocol can improve patient comfort and workflow without the loss of diagnostic kinetic information.

SSQ01-06 Diagnostic Value of Electronic Property Tomography (EPT) For Differentiating Benign from Malignant Lesions: Comparison with Standard Dynamic Contrast-Enhanced MRI

Thursday, Nov. 30 11:20AM - 11:30AM Room: E450A

Participants
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PURPOSE

To compare diagnostic utility of EPT to standard DCE-MRI for differentiating benign from malignant lesions.

METHOD AND MATERIALS

Between January 2014 and December 2015, consecutive 67 patients with 83 breast lesions (33 benign and 50 malignant) underwent an IRB-approved 3T-MRI, including 3D turbo spin echo (TSE) sequence and standard dynamic contrast-enhanced (DCE)-MRI scans. Given the transceive phase Φ of a TSE image, EPT estimates tissue conductivity via $\sigma=(\Delta\Phi)/(2\mu o\omega)$ with Δ the Laplace operator, μo the magnetic permeability (assumed to be constant), and ω the Larmor frequency. The lesions were segmented semi-automatically using subtraction DCE-MR images (post-pre-contrast), and the segmented volume of the lesions was registered to the phase images. Conductivity reconstruction was performed only inside lesion volumes, and the mean conductivity of the lesion was obtained. From the standard DCE-MRI, a single voxel whithin each lesion that had the highest signal intensity on the early image was selected, and the initial enhancement rate and the signal enhancement ratio (SER) were caluculated as follows: the initial uptake = (SIearly-SIpre)/SIpre, SER = (SIearly-SIpre)/(SIdelayed-SIpre). The parameters from EPT and standard DCE-MRI were conpared between benign and malignant lesions. P<0.05 was considered significant. After Bonferroni correction of 4 multiple comparisons, the critical value became <0.0125(0.05/4).

RESULTS

The mean conductivity of malignant lesions (1.32±1.21S/m) was significantly higher than benign lesions (-0.09±1.77S/m) (p<0.0001). The SER of malignant lesions (1.19±0.27) was significantly higher than benign lesions (0.89±0.32S/m)(p<0.0001), whereas the initial uptake did not show significant difference between benign and malignant lesions (p=0.027). Receiver operating curve (ROC) analysis revealed that the are under the curve (AUC) of the mean conductivity and SER was 0.76 and 0.82, respectively. There was no significant difference in AUC between the mean conductivity and SER (p=0.41).

CONCLUSION

The mean conductivity might be comparable to standard DCE-MRI for differentiatiation between benign and malignant lesions.

CLINICAL RELEVANCE/APPLICATION

The mean conductivity measured by EPT might be comparable to standard DCE-MRI for differentiation between benign and malignant lesions.

SSQ01-07 Prediction of Low-Risk Ductal Carcinoma in Situ using Whole-Lesion Histogram Analysis of the Apparent Diffusion Coefficient

Thursday, Nov. 30 11:30AM - 11:40AM Room: E450A

Participants
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PURPOSE

To investigate the value of histogram-derived apparent diffusion coefficient (ADC) metrics obtained from whole-lesion assessment of diffusion-weighted imaging (DWI) for predicting a low-risk ductal carcinoma in situ (DCIS).

METHOD AND MATERIALS

The institutional review board approved this retrospective study, and waived informed consent. The authors identified 93 women (mean age, 51.9 years; range, 32-76 years) with pure DCIS, who had undergone preoperative MR imaging and DWI from 2013 to 2016. Histogram analysis of pixel-based ADC data of the whole tumor volume and conventional measurement of the mean ADC by placing regions of interest were performed by two radiologists. The mean, median, and 5th and 95th percentile ADCs obtained from whole-lesion histogram and the ROI-based mean ADC were compared between low-grade and non-low-grade DCIS. Associations of whole-lesion histogram ADC metrics with low-grade DCIS were evaluated by receiver operating characteristics (ROC) curve and logistic regression analyses.

RESULTS

In whole-lesion histogram analysis, the mean, median, and 5th and 95th percentile ADCs were significantly different between low-grade and non-low-grade DCIS (1.522, 1.536, 1.207, and 1.854 × 10-3mm2/s versus 1.270, 1.261, 0.917, and 1.657 × 10-3mm2/s, respectively; P=0.004, P=0.004, P=0.003, and P=0.024, respectively). However, ROI-based mean ADC was not significantly different (P=0.278). ROC curve analysis for the differentiation between low-grade and non-low-grade DCIS groups revealed that the most effective threshold for the 5th percentile ADC was > 1.078 × 10-3mm2/s (sensitivity 80%, specificity 75.9%, area under the curve [AUC] 0.786, P=0.001). No differences in the AUC were found among the ADC metrics of whole-lesion histogram. Multivariate regression analysis revealed that a higher 5th percentile ADC (> 1.078× 10-3 mm2/s; odds ratio [OR]=10.494, P=0.016), smaller tumor size (<= 2cm; OR=12.692, P=0.008), and low Ki-67 status (< 14%; OR=10.879, P=0.046) were significantly associated with low-grade DCIS.

CONCLUSION

Assessment with whole-lesion histogram analysis of the ADC could be helpful for identifying patients with low-risk DCIS.

CLINICAL RELEVANCE/APPLICATION

Whole-lesion histogram ADC metrics may serve as DWI biomarkers of DCIS biology, which could help to reduce overtreatment in patients with low-risk DCIS.

SSQ01-08 Unenhanced Breast MRI during Pregnancy Using Diffusion Tensor Imaging (DTI) Parametric Maps: A Feasibility Study

Thursday, Nov. 30 11:40AM - 11:50AM Room: E450A

Participants
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PURPOSE

To investigate the feasibility and clinical utility of DTI parametric maps in the diagnostic workup of pregnancy-associated breast cancer

METHOD AND MATERIALS

This prospective study was approved by our institutional IRB, and a signed informed consent was obtained from all participants. Since November 2016, thirteen pregnant patients (median gestational age: 17 weeks, range:8-30w) were examined by unenhanced breast MRI protocol. Indications included: newly diagnosed pregnancy-associated breast cancer (PABC) (n=5), follow-up on high-risk patients (n=7) and on neoadjuvant-chemotherapy (NAC) treated patient (n=1). MRI protocol included T2-weighted and DTI sequences, recorded at 1.5T (GE) using a breast coil, with total scan duration of ~12min. DTI was acquired using 32 directional diffusion gradients and 0, 700 s/mm2 b-values. DTI parametric maps of the principal diffusion coefficients (λ1,λ2,λ3), mean diffusivity (MD), fractional anisotropy (FA) and maximal anisotropy index (λ1-λ3) were generated and analyzed at pixel resolution using a proprietary software. Regions of interest (ROIs) of lesions and the normal fibroglandular tissue were delineated on λ1 maps and were statistically compared using Student's t-tests.

RESULTS

All scans were completed. One patient complained on positional discomfort during the scan which was endured with extra supports but still ended up with significant artifacts. All other scans were in diagnostic quality and artifact-free. All five known tumors were detected by DTI maps of λ1, λ2, λ3, MD and λ1-λ3 in agreement with their localization based on clinical/mammographic/sonographic findings, exhibiting substantial contrast compared with the ROIs of the apparently-normal surrounding tissue (p<0.001, for all). Representative images of 36 y patient diagnosed with IDC at the 17th week of pregnancy are presented in Fig1. FA ROIs did not help in differentiating malignant and normal tissues (p=0.48). Scans of high risk patients did not

reveal any new suspicious finding, in agreement with US exam. Residual tumor was not identified in the scan of the patient receiving NAC, in agreement with DCE MRI, performed several weeks later after delivery.

CONCLUSION

DTI examination is safe, non-invasive, fast and well-tolerated by pregnant patients and DTI parametric maps helped in characterizing PABC.

CLINICAL RELEVANCE/APPLICATION

DTI appears to have a promising diagnostic value in breast imaging during pregnancy

SSQ01-09 Texture Analysis for Non-Mass Enhancement on Breast MRI: A Preliminary Experience

Thursday, Nov. 30 11:50AM - 12:00PM Room: E450A

Participants
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PURPOSE

To evaluate the usefulness of texture analysis for diagnosis of non-mass enhancement (NME) on breast dynamic contrast enhanced (DCE) magnetic resonance imaging (MRI).

METHOD AND MATERIALS

84 patients with 86 NME lesions on breast MRI (from March 2010 to March 2013) were enrolled in this retrospective study (35 benign and 51 malignant with 33 invasive breast cancers (IBC) and 18 ductal carcinomas in situ (DCIS)). Three-dimensional histogram analysis and gray-level co-occurrence matrix (GLCM) based textural features were extracted from lesions' volume of interest (VOI) depicted on both early and delayed phases of DCE-MRI acquired by a 1.5T MRI scanner. In each NME, two different VOIs were placed; VOI-1 was carefully set to include only the enhancing areas, and VOI-2 was placed to cover the whole enhancing region including intervenient non-enhancing areas. Mann-Whitney U-test with false discovery rate control was applied for two groups to compare the extracted textural features in VOI-1; 1) benign and malignant lesions, 2) IBC and DCIS. Several diagnostic models were constructed with elastic net using VOI-1 and -2 data. Receiver operating characteristic (ROC) analysis was performed to evaluate these models. Then the models from 1.5T MRI were validated by comparing it with 3T DCE-MRI data sets (10 benign and 20 malignant with 10 IBC and 10 DCIS).

RESULTS

Total of 138 textural features were derived from VOI-1, and some of them showed statistical significant difference in benign vs malignant and in IBC vs DCIS. By the ROC analysis of benign vs malignant NME, area under curves (AUC) with best performance were 0.854 and 0.849, respectively for VOI-1 and -2. Analysis of IBC vs DCIS were 0.936 and 0.933, respectively for VOI-1 and -2. Diagnostic performance between different VOI settings did not show statistically significant differences neither in benign vs malignant ($p = 0.891$), nor in IBC vs DCIS ($p = 0.933$). The AUCs of 1.5T were comparable to the results of 3T DCE-MRI.

CONCLUSION

Texture analysis using breast DCE-MRI for NME showed good diagnostic performance for the differentiation of malignant vs benign lesions, and of DCIS vs IBC, regardless of the VOI settings.

CLINICAL RELEVANCE/APPLICATION

Texture analysis of breast MRI may be one of the promising tools to improve the diagnostic performance and may provide us with quantitative measures of internal structure for non-mass enhancement.

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SSQ02

Science Session with Keynote: Cardiac (Coronary Artery Disease: General II)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S502AB

CA CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Gregory Kicska, MD, PhD, Seattle, WA (*Moderator*) Nothing to Disclose

Sub-Events

SSQ02-01 Cardiac Keynote Speaker: Coronary Artery Stent Evaluation by CT Angiography

Thursday, Nov. 30 10:30AM - 10:50AM Room: S502AB

Participants
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SSQ02-03 Head-To-Head Comparison between Coronary CT Angiography and OCT for In-Stent Restenosis after Drug-Eluting Stent Implantation

Thursday, Nov. 30 10:50AM - 11:00AM Room: S502AB

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PURPOSE

To evaluate characteristics of coronary computed tomography angiography (CCTA) findings of neointimal hyperplasia in patients diagnosed coronary stent failure and compare the quantitative measurements of CCTA with optical coherence tomography (OCT) defined in-stent neoatherosclerosis in section-to-section-level.

METHOD AND MATERIALS

Total number of 370 CCTA and OCT cross-sections (18 coronary stent lesions in 18 consecutive patients who diagnosed stent failure from Aug 2008 to Dec 2013 and underwent both pre-procedural OCT and CCTA) were included. Stent area, lumen area, in-stent intimal hyperplasia (IH) area, IH% (IH area/lumen areax100), lipid quadrant, and presence of thin-cap fibroatheroma (TCFA), rupture and thrombus were evaluated using OCT. CT measurements (stent area, lumen area, IH area and IH%) were compared with OCT-derived parameters. Lumen and IH attenuation were measured on CT. CT parameters were analyzed according to lipid quadrant (sections with <= 2 lipid quadrants (n=146) vs. 3 or 4 quadrants (n=117)) or presence of TCFA (n=39).

RESULTS

Stent area (r=0.66, p<0.001) and lumen area (r=0.43, p<0.001) showed moderate correlation, however, IH area (r=0.34, p<0.001) and IH% (r=0.19, p<0.001) showed mild or weak correlation between CT and OCT. Sections with high lipid quadrant (3 or 4) showed low IH attenuation (395 Hounsfield unit [HU]) on CT compared to those with <= 2 lipid quadrant (p<0.001). Neointimal rupture (n=15) or thrombi (n=17) were noted only in sections with high lipid quadrant (each, p<0.001). In multivariate logistic analysis, high lipid quadrant was significantly associated with lumen attenuation (OR,0.994; 95%CI 0.989 - 1.00; p=0.04), IH% (OR, 1.046; 95%CI 1.004 - 1.090; p = 0.03) and IH attenuation (OR, 0.996; 95%CI 0.992 - 0.999; p = 0.01) measured on CT. Sections with TCFA presented larger IH area (3.7mm2) and smaller lumen area (1.8 mm2) than those without TCFA (3.2 mm2 and 2.1 mm2). Presence of TCFA was associated with IH% (OR, 1.057; 95%CI 1.006 - 1.111;p=0.03) on CT.

CONCLUSION

Stent area and lumen area were moderately correlated between CT and OCT. High lipid quadrant in OCT is associated with lumen attenuation, IH attenuation and IH% on CT. TFCA is associated with IH% measured on CT.

CLINICAL RELEVANCE/APPLICATION

Quantitative parameters for in-stent restenosis measured on CCTA may be helpful to assess the presence of high lipid quadrant or

Quantitative parameters for in-stent restenosis measured on CCTA may be helpful to assess the presence of high lipid quadrant of TCFA.

SSQ02-04 Non-invasive Evaluation of Soft-Plaque-Restenosis in Coronary Artery Stents: Initial In-vitro Comparison of a Spectral Photon Counting CT and a Spectral Dual-Layer CT System

Thursday, Nov. 30 11:00AM - 11:10AM Room: S502AB

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PURPOSE

Even when compared to the latest spectral dual layer CT systems (SDLCT) future spectral photon counting detector CT systems (SPCCT) promise an improved spatial resolution as well as decreased stent related blooming artifacts, two likely beneficial characteristics for the challenging task of evaluating in-stent restenosis. Therefore, we investigated the influence of different conventional (Conv) and monoenergetic (MonoE) reconstructions from a SDLCT and a SPCCT on the delineation of soft-plaque-restenosis in coronary stents.

METHOD AND MATERIALS

Artificial stenosis (~30HU) were implanted into 10 different coronary stents (diameter 3mm) embedded in plastic tubes filled with Iohexol-based contrast agent (~400HU). CT data was acquired with a 128-slice SDLCT (IQon, Philips, 120kV, 100mAs, 0.2x0.2x0.67mm3 voxel size (VS)) and a 9-slice SPCCT (Prototype, Philips, 120kV, 100mAs, 0.2x0.2x0.25mm3 VS). Sharp FBP kernels were used for reconstructions with Conv and MonoE at 50, 70, 100 and 140keV. Visibility of the stenosis and the remaining lumen was evaluated by 2 readers for each stent and reconstruction using a 5-point Likert scale: 1=image quality impedes lumen assessment; 2=lumen appears stenosed, extent unclear; 3=stenosis and extent clear, remaining lumen undistinguishable; 4=stenosis clear and remaining lumen slightly distinguishable; 5= stenosis and remaining lumen clear.

RESULTS

Interrater agreement was very good (weighted kappa=0.9). Stenosis delineation was best in Conv, 50 and 70keV MonoE SPCCT images (median score 5). Differentiation was significantly more difficult in the corresponding SDLCT images (median score 3; $p<0.01$). Despite visibly lower stent blooming artifacts, 100 and 140keV MonoE images showed significantly poorer results compared to the corresponding 50keV MonoE images due to reduced contrast enhancement resulting in impaired visualization of the unaltered stent lumen (median score of 2 for 100keV and 1 for 140keV on both scanners; $p<0.01$).

CONCLUSION

Evaluation of soft-plaque-restenosis can be significantly improved by using conventional and low keV MonoE reconstructions of future SPCCT. High keV MonoE reconstructions are not recommended for coronary stent assessment with SPCCT or SDLCT due to impeded stenosis delineation.

CLINICAL RELEVANCE/APPLICATION

SPCCT will have the potential to significantly improve the important but still challenging non-invasive evaluation of coronary stents and possible restenosis.

SSQ02-05 Low-Dose Coronary CT Angiography with 30 Ml Contrast Medium And Monochromatic Imaging Using Dual-Layer Spectral Detector CT

Thursday, Nov. 30 11:10AM - 11:20AM Room: S502AB

Participants
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PURPOSE

To investigate the feasibility of monochromatic imaging for coronary CT angiography (CCTA) with 30 ml contrast medium and low radiation dose.

METHOD AND MATERIALS

Thirty patients with suspected ischemic heart disease underwent CCTA on a dual-layer spectral detector CT. All imageswereacquired with step-and-shoot mode using 120 kVp, 104.4 ± 27.6 mAs with automatic current modulation. Due to the nature of dual-layer detector, the conventional and spectral image data were acquired within the same scan. The conventional and monochromatic 50 keV images were reconstructed. The objective image quality (IQ) was evaluated by placing region-of-interest (ROI) on aorta root (AO), left main artery (LM), distant segment of left anterior descending (LAD), left circumflex (LCX) and right coronary artery (RCA). The attenuation, noise and signal-to-noise ratio (SNR) were measured on conventional and monochromatic images. The subjective IQ was assessed by 2 raters independently using a 4-point scale (1 - excellent, 4 - undiagnostic).

RESULTS

The attenuation of AO, LM, LAD, LCX and RCAwas 311.9 ± 73.9, 297.4 ± 77.3, 210.6 ± 45.3, 214.8 ± 61.1 and 233.1 ± 82.1 HU on conventional images, 634.5 ± 173.2, 569.9 ± 175.7, 353.5 ± 80.9, 372.9 ± 105.4 and 410.5 ± 153.7 HU on monochromatic images. The noise and SNR of AO was 24.8 ± 3.7 and 12.9 ± 4.3 on conventional images, 20.9 ± 2.4 and 30.8 ± 9.6 on monochromatic

images. The attenuation, noise and SNR were significantly better on monochromatic images than those on conventional images (all $p < 0.01$). The subjective IQ score was 2.1 ± 0.5 and 1.2 ±0.4 in two groups.The volume CT dose index, dose length product and effective dose was 12.3 ± 3.3 mGy, 142.9 ± 44.7 mGy×cm, and 2.0 ± 0.6 mSv.

CONCLUSION

The monochromatic 50 keV images provide superior image quality with 30 ml contrast medium and 2 mSv radiation dose in CCTA study compared with conventional 120 kVp images.

CLINICAL RELEVANCE/APPLICATION

It is feasible to apply spectral imaging in CCTA study with low dose of contrast medium and radiation.

SSQ02-06 Accuracy of Virtual Non-Contrast Image of Coronary CT Angiography with Fast Kilo Voltage Switching Dual-Energy CT (DECT): Compared With Non-Contrast Image of Single-Energy CT (SECT)

Thursday, Nov. 30 11:20AM - 11:30AM Room: S502AB

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PURPOSE

The virtual non-contrast (VNC) images technique in fast kilo voltage switching single-source dual-energy CT (ssDECT) is useful to reduce scan dose. The purpose of this study was to evaluate the accuracy of CT-values in VNC images reconstructed from dual-energy coronary CT angiography using the fast kilo voltage switching technique performed on a ssDECT scanner, compared with non-contrasted single-energy CT (SECT) images for true non-contrast images (TNC).

METHOD AND MATERIALS

Twenty patients with coronary artery disease (between February 22nd, 2016 and April 4th, 2016) had non-contrasted SECT (120 kilovoltage) for calcium score and ssDECT for coronary angiography using fast kilovoltage switching dual-energy CT technique (Revolution GSI, GE Healthcare).TNC images were reconstructed from non-contrasted SECT for calcium score, and VNC images were reconstructed from ssDECT for coronary angiography. We measured CT-values of, right atrium (RA), right ventricle (RV), pulmonary artery (PA), left atrium (LA), left ventricle (LV), and ascending aorta (A-Ao) in TNC images and VNC images on an Advantage Workstation ver.4.7 (GE Healthcare). CT-values were compared between TNC images and VNC images.

RESULTS

In TNC images, mean CT-values for RA, RV, PA, LA, LV, and A-Ao were 42 ± 6 Hounsfield Unit (HU), 44 ± 4 HU,40 ± 4 HU, 40 ± 3 HU,42 ± 6 HU,and 41 ± 4, respectively. In VNC images, mean CT-values for RA, RV, PA, LA, LV, and A-Ao were 40 ± 6, 43 ± 6, 46 ± 9, 47 ± 10, 53 ± 11, and 47 ± 10, respectively. There was a no significant difference between CT-values of RA in TNC images and RA in VNC images ($P=0.333$), and between RV in TNC images and RV in VNC images ($P=0.923$). In VNC images, mean CT-values for PA, LA, LV, and A-Ao were about 6 to 11 HU higher than that in TNC ($P<0.05$).

CONCLUSION

CT-values in VNC reconstructed from fast kilo voltage switching ssDECT for coronary angiography were close to that in non-contrasted SECT images.

CLINICAL RELEVANCE/APPLICATION

The virtual non-contrast images (VNC) technique of ssDECT is useful for low DOSE clinical application.

SSQ02-07 Feasibility of Combining Coronary with Carotid and Cerebrovascular CT Angiography using CT with High Temporal Resolution and Wide Detector Coverage

Thursday, Nov. 30 11:30AM - 11:40AM Room: S502AB

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PURPOSE

To explore the feasibility of combining coronary with carotid and cerebrovascular CT angiography (CCCTA) using CT system with high temporal resolution and wide detector coverage.

METHOD AND MATERIALS

60 patients with suspected cardiovascular and cerebrovascular disease were randomly divided into groups A and B. Group A (n=30) with integrated CT workflow: CCTA immediately followed by CCCTA after 1.1s delay with one injection of contrast agent. Group B used the traditional CT workflow: CCTA after contrast injection; patient rested for 30min, and contrast re-injection for CCCTA. The amount of the contrast in each injection was weight-dependent at 0.8ml/kg (370mgI/ml) and the flow rate was 5ml/s. The subjective image quality of CTA was assessed by two senior radiologists using a 4-point system for blind assessment (4=best). The

CT values and SD values of the aortic root, right coronary artery opening, left anterior descending branch opening, left rotation opening and fat in the anterior chest wall; and of the aortic arch, carotid cartilage median layer, internal carotid artery M1 segment and muscle at the same level were used to evaluate the objective image quality of CCTA and CCCTA, respectively. SNR and CNR for vessels were calculated. The effective dose was calculated. The corresponding image quality and radiation dose between groups A and B were compared.

RESULTS

The average contrast amount in group A was 51ml, significantly smaller than the 105ml in group B. The examination time was reduced from 40min in group B to 5min in group A. Group B had slightly better SNR and CNR values than group A in CCTA. However, There was no difference in the subjective score between the two groups (3.40±0.67 vs. 3.50±0.63) (P=0.56) and all CCTA images were diagnostic. There was no difference in both objective and subjective image quality of CCCTA between the two groups (P>0.05). There was no difference in total radiation dose between group A (2.42±1.10mSv) and group B (2.94±1.25mSv) (P>0.05).

CONCLUSION

It is feasible to combine CCTA with CCCTA using a 256-row, 16cm wide-detector CT system to simplify workflow, reduce contrast dose and maintain diagnostic images of the heart and head.

CLINICAL RELEVANCE/APPLICATION

Atherosclerotic plaques usually occur in coronary artery,carotid and cerebrovascular arteries simultaneously. Combining CCTA with CCCTA may show all the lesions with one scan.

SSQ02-08 Radiologists Now Predominate in Use of Coronary CT Angiography

Thursday, Nov. 30 11:40AM - 11:50AM Room: S502AB

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PURPOSE

Controversy has long existed between radiologists and cardiologists over who should perform cardiac imaging, and this has extended to the recently-developed technique of coronary CT angiography (CCTA). Our purpose was to compare recent trends in use of CCTA between the 2 specialties.

METHOD AND MATERIALS

HCPCS codes for CCTA have existed since 2006. We reviewed the Medicare Physician/Supplier Procedure Summary (PSPS) Master Files for 2006-2015 and selected the codes for CCTA. Medicare's physician specialty codes identified the specialty of the provider. The PSPS files provide procedure volume for each code each year and we then calculated utilization rates per 100,000 Medicare fee-for-service beneficiaries (37.5 million in 2015) in all places-of-service. We studied the long term utilization trends for CCTA and also for 2 competing modalities, stress echo and myocardial perfusion imaging (MPI).

RESULTS

The total Medicare utilization rate per 100,000 of CCTA was 99 in 2006, rising to 210 in 2007. However, the rate dropped sharply in subsequent years and reached a nadir of 107 in 2012 and 2013. It then increased the next 2 years to 117 in 2015 (+9.3% compared with nadir). Among cardiologists, the rate went from 59 in 2006 to 126 in 2007. It then dropped continuously, reaching a nadir of 47 in both 2014 and 2015. Among radiologists, the rate increased from 31 in 2006 to 67 in 2007, but then declined to a nadir of 44 in 2010. However, since then, radiologists' rate has increased steadily to 65 in 2015. In that final year, radiologists' utilization rate was 38% higher than that of cardiologists. Total utilization rate trends for stress echo and MPI were down in recent years but the levels remained far higher than that for CCTA.

CONCLUSION

In 2007 (the second year in which codes were available for CCTA), cardiologists did almost twice as many CCTAs as radiologists. However, by 2015, radiologists did substantially more than cardiologists. Nevertheless, utilization of both MPI and stress echo is far higher than that for CCTA. Low reimbursement rates and frequent denials by payers may have contributed to the abrupt CCTA declines in the early years.

CLINICAL RELEVANCE/APPLICATION

The utilization rate of CCTA has seen a small increase in the most recent years for which data are available.

SSQ02-09 Improving Specificity of Coronary CT Angiography for the Detection of Functionally Significant Coronary Artery Disease: A Deep Learning Approach

Thursday, Nov. 30 11:50AM - 12:00PM Room: S502AB

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PURPOSE

Coronary computed tomography angiography (CCTA) is an increasingly important diagnostic tool for the detection of coronary artery disease (CAD). However, due to calcium blooming and beam hardening, specificity for diagnosing functionally significant CAD is limited. The purpose of this study was to evaluate to what extent the specificity of CCTA for detection of functionally significant CAD could be improved by combining simple stenosis grading with deep-learning based analysis of left ventricular myocardium (LVM).

METHOD AND MATERIALS

We retrospectively included 126 patients (77% male, 58.7±9.5 years) who underwent CCTA prior to invasive fractional flow reserve (FFR). Functionally significant CAD was defined as an invasively measured FFR value below 0.78. First, the presence and degree of coronary artery stenosis was analyzed using the CAD-RADS system. Patients without a significant stenosis reported on CCTA scans were scored as functionally non-significant. For the remaining patients, fully automatic deep learning analysis of the LVM was used to identify presence of functionally significant CAD. LVM was first segmented using a convolutional neural network and then characterized by a convolutional auto-encoder (CAE). Based on the encodings generated by the CAE a support vector machine classifier identified patients with functionally significant stenosis. Diagnostic performance of this combined analysis was evaluated and compared with patient identification based only on >=50% stenosis degree as measured in CCTA.

RESULTS

FFR was significant in 64 (51%) of the patients. Sensitivity and specificity of stenosis degree reported on CCTA alone were 91% and 18%, respectively. Adding deep-learning based analysis of LVM to stenosis detection resulted in improved specificity with a slight decline in sensitivity. The combined evaluation resulted in a sensitivity of 83% and a specificity of 73%.

CONCLUSION

Our results show that, at the expense of only a mild sensitivity decrease, a combination of clinical stenosis evaluation and automatic LVM analysis in CCTA led to substantial increase of the specificity.

CLINICAL RELEVANCE/APPLICATION

Adding deep learning analysis of LVM to stenosis assessment holds the potential to substantially increase specificity of CCTA and to decrease number of patients unnecessarily referred to invasive FFR.

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SSQ03

Cardiac (MRI)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S504AB

CA MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

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Sub-Events

SSQ03-01 Multicenter Study Comparing PSIR Motion Correction Late Gadolinium Enhancement Sequence with TurboFLASH and TrueFISP Late Gadolinium Enhancement Sequences

Thursday, Nov. 30 10:30AM - 10:40AM Room: S504AB

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PURPOSE

The Phase-Sensitive Inversion Recovery with Motion Correction (PSIRMoCo) is an improved single-shot rapid LGE sequence, which has higher spatial resolution compared to the traditional TrueFISP sequence and shorten acquisition time compared to the TurboFLASH sequence. This study aims to investigate a PSIRMoCo prototype against TurboFLASH and TrueFISP in terms of acquisition time and image quality.

METHOD AND MATERIALS

Inclusion criteria was patients/volunteers undergoing LGE CMR. Exclusion criteria was patients who did not have late gadolinium enhancement images. A total of 70 subjects (70% male, 17% had arrhythmia, 2% were poor breath-holders) were recruited in two hospitals. Patients were recruited consecutively for a 6-month period. Data was all acquired on 1.5T MAGNETOM Avanto scanner (Siemens Healthcare, Erlangen, Germany). MRI TurboFLASH images were acquired first at 8 minutes post contrast injection followed by the PSIRMoCo sequence and the TrueFISP PSIR sequence. Images with poor contrast differentiation between the myocardium and blood pool were excluded from the analysis. Acquisition time was measured based on the timings from the MRI times stated on the images. Image quality was assessed by 2 doctors separately without access to the image information, using a 4-point Likert scale (4 for the best, 1 for the worst). A P-value<0.05 was regarded as statistically significant. ANOVA, Kruskal-Wallis H test and Mann-Whitney U test were used for comparing the three groups.

RESULTS

The total scan times for PSIRMoCo, TurboFLASH and TrueFISP were 187±43 sec, 636±144 sec, and 164±37sec, respectively (p<0.001). There was no statistically significant difference in scan time between PSIR MoCo and TrueFISP. Image quality scores of the three groups were 3.8±0.26, 3.3±0.47, and 3.5±0.31, respectively (p=0.0001). Separately, PSIRMoCo showed a statistically higher image quality score compared to TurboFLASH (p<0.0001) and TrueFISP (p=0.008).

CONCLUSION

PSIR MoCo shows statistically significant time saving compared to TurboFLASH and better image quality compared to TurboFLASH and TrueFISP.

CLINICAL RELEVANCE/APPLICATION

PSIR MoCo should be considered for routine use instead of TurboFLASH as it saves approximately just under 8 minutes in scan time with improved image quality.

SSQ03-02 Detection of Patients with High-Risk Coronary Artery Disease Using Coronary Flow Velocity Reserve:

3T-MRI Fast Velocity-Encoded Cine Study

Thursday, Nov. 30 10:40AM - 10:50AM Room: S504AB

Participants
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PURPOSE

We previously developed a method to measure coronary flow velocity reserve (CFVR) in the left main trunk (LM) during stress (ATP (0.16mg/kg/min)) and at rest non-invasively mainly using healthy volunteers. The purpose of this current study is to evaluate the method's diagnostic value in detecting patients with high-risk coronary artery disease (CAD).

METHOD AND MATERIALS

Fifty-nine patients with suspected CAD (age; 67 ± 11 yr, male; n = 36) who underwent 3.0-tesla (T) magnetic resonance imaging (MRI) and angiography were studied. Coronary flow velocity in LM was measured with breath-hold velocity-encoded cine using 3.0-T MRI during ATP stress and at rest. CFVR was calculated by dividing peak-velocity during stress by that at rest. The extent and severity of angiographic disease of LM, left anterior descending artery (LAD), and left circumflex artery (LCx) were estimated with the use of the Leaman score (LS) which is able to stratify the risk of coronary artery using angiography.

RESULTS

Among the patients evaluated, 24 had 1-vessel disease (LAD (n = 17), LCx (n = 7)) and 18 patients had 2-vessel disease. Four patients had => 50% stenosis in LM. Fifty-one out of 59 patients showed low LS (0-10) and 8 had high LS (=>10.5 (equivalent to proximal LAD = 90-99%)). CFVR of CAD patients with high LS which means high-risk CAD was significantly lower than that of patients with low LS (1.57 ± 0.31 vs. 2.18 ± 0.73, $p < 0.05$) (Figure). In receiver operating characteristic (ROC) analysis of CFVR for detection of high-risk CAD patients, the area under the ROC curve was 0.79 ($p = 0.0296$). Sensitivity was 100% and specificity was 62.8% using a cutoff of 1.98 for detection of high-risk CAD patients.

CONCLUSION

Low CFVR in LM derived by velocity-encoded cine using 3.0-T MRI can predict downstream coronary atherosclerotic burden. This method is a simple and reliable index to detect patients with high-risk CAD without radiation exposure.

CLINICAL RELEVANCE/APPLICATION

Coronary flow velocity reserve measured using 3.0-T MRI is able to evaluate severity of coronary artery disease with high sensitivity.

SSQ03-03 Gadolinium-enhanced Cardiac MR Exams of Human Subjects are Associated with Significant Increases in the DNA Repair Marker 53BP1 but Not the Damage Marker γH2AX

Thursday, Nov. 30 10:50AM - 11:00AM Room: S504AB

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PURPOSE

To examine whether MR exams cause double-strand (ds) DNA damage by analyzing changes in the DNA damage and repair markers γH2AX and 53BP1 in patients who underwent a cardiac magnetic resonance (MR) exam.

METHOD AND MATERIALS

Our prospective study of outpatients scheduled for a 1.5 T gadolinium-enhanced cardiac MR exam was subject to Institutional Review Board approval. Patients with history of malignancy or who were receiving chemotherapy, radiation therapy, or steroids were excluded. MR sequence data were recorded for each patient. Blood samples were obtained from immediately before and after MR exposure. An automated immunofluorescence assay quantified γH2AX or 53BP1 foci number in isolated peripheral blood mononuclear cells. Changes in foci number were analyzed within patients using the Wilcoxon signed-rank test. Clinical and MR procedural characteristics were compared between patients who had a >10% increase in γH2AX or 53BP1 foci numbers and patients who did not.

RESULTS

Sixty patients (median age: 55 years, 39 males) were enrolled in our study. The number of γH2AX foci did not significantly change following cardiac MR (median foci per cell pre-MR=0.11, post-MR=0.11, p=.90), but the number of 53BP1 foci significantly increased following MR (median foci per cell pre-MR=0.46, post-MR=0.54, p=0.0140). Clinical and MR characteristics did not differ significantly between patients who had at least a 10% increase in foci per cell and those who did not.

CONCLUSION

MR exposure leads to a small (median 17%) increase in 53BP1 foci, suggesting increased DNA repair. Accordingly, a lack of increase in number of foci of the ds DNA damage marker γH2AX does not necessarily indicate an absence of DNA damage.

CLINICAL RELEVANCE/APPLICATION

1. Elevated DS DNA repair marker levels suggest that cardiac MR may cause DS DNA damage, and further study using both γH2AX and 53BP1 is necessary.

SSQ03-04 Detection of Myocardial Scar by Late Gadolinium Enhancement Cardiac MR using Gadoterate Meglumine

Thursday, Nov. 30 11:00AM - 11:10AM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

To compare the efficacy of late gadolinium enhancement cardiac MR (LGE-CMR) for myocardial scar detection between 2 macrocyclic GBCAs (gadoterate meglumine vs. gadobutrol).

METHOD AND MATERIALS

40 subjects (61±11 years, 67.5% men) who were referred for evaluation of cardiomyopathy with LGE-CMR performed using standard of care 0.2mmol/kg gadobutrol were recruited prospectively within an 8-week period for a research CMR scan using 0.2mmol/kg gadoterate meglumine. Both clinical and research CMR scans were performed at 1.5T. All subjects underwent a standard CMR protocol consisting of multiplanar cine steady state free precession (SSFP) and post contrast delayed enhanced PSIR SSFP and PSIR TurboFlash sequences. Myocardial scar quantification was performed on short-axis PSIR-TurboFlash images using commercially available software (Circle 5.3, Calgary, Canada) and myocardial scar percentage mass was calculated. Qualitative scar analysis was performed by 2 observers using the 16-segment AHA model and the area of scar per segment (0=none, 1=1-25%, 2=26-50%, 3=51-75%, 4=76-100% of the segment area) was scored. Segmental ratings were summed across all 16 segments to derive a global scar score for each scan. Reader confidence in visualizing the scar tissue for each agent was recorded on a 5-point scale (1=poor, 2=fair, 3=good, 4=very good, 5=excellent).

RESULTS

With PSIR SSFP technique, percentage myocardial scar mass averaged 5.9±9.8% and 5.2±7.2% for gadobutrol and gadoterate meglumine, respectively (p>0.05, ICC=0.89, 95% CI:0.78-0.94). With PSIR TurboFlash technique, percentage myocardial scar mass was 7.19±11 and 6.03±8.51 for gadobutrol and gadoterate meglumine, respectively (p>0.05, ICC=0.96, 95% CI:0.93-0.98). Global qualitative segmental LGE scores showed comparable scar detection using gadobutrol vs. gadoterate meglumine (5.3±7.5 vs. 5.4±7.2, p>0.05). Reader confidence for scar visualization was similar between gadobutrol and gadoterate meglumine (4.35±0.7 vs. 4.22±0.6, p>0.05).

CONCLUSION

Gadoterate meglumine is comparable to gadobutrol for identifying myocardial scar on LGE-CMR both qualitatively and quantitatively and can detect scar with a similar degree of diagnostic confidence as Gadobutrol.

CLINICAL RELEVANCE/APPLICATION

Gadoterate Meglumine, an alternative macrocyclic GBCA to the more routinely used Gadobutrol, has recently become available in the U.S. and may have comparable efficacy for detecting myocardial scar on routine LGE-CMR

SSQ03-05 Diffuse Myocardial Fibrosis in Diabetes Mellitus: Findings From t1 Mapping Imaging and Cardiac MRI Strain

Thursday, Nov. 30 11:10AM - 11:20AM Room: S504AB

Participants
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PURPOSE

To investigate diffuse myocardial fibrosis and the relationship between cardiac MRI strain in diabetes mellitus (DM) using T1 mapping and cardiac tissue tracking.

METHOD AND MATERIALS

Thirty-one patients with DM without impairment of renal function (Group1), 21 cases of DM with impairment of renal function (Group2) and 23 normal control individuals were enrolled. All patients underwent cardiovascular magnetic resonance (CMR), including cardiac cine sequence and T1 mapping MOLLI sequence. Cardiac function indexes, tissue tracking and T1 mapping were all measured by cvi42 and compared statistical. Pearson's correlation between the T1 mapping parameters and the left cardiac strain parameters were also investigated.

RESULTS

All the patients recruited finished CMR and the baseline characteristics were recorded. Group2 presented with higher pre-contrast T1 value than Group1 and control group (Group2: 1314.80±43.72ms; Group1: 1259.12±42.48ms; control group: 1264.25±47.45ms, both $P<0.05$). Regarding the post-contrast T1 value, lower post-contrast T1 value were observed in Group2 but the differences were not statistically significant (Group2: 490.25±58.59ms; Group1: 521.61±70.50ms; control group: 508.20±35.82ms, both $P>0.05$). Compared with control group, Group1 and Group2 had significantly higher ECV (Group1: 31.02±2.97ms; Group2: 34.09±4.23; control group: 27.39±2.40ms, both $P<0.05$). Negative correlation was showed between the circumferential peak diastolic strain rate and ECV in Group1 and Group2 ($r=-0.459$, $r=-0.459$, $P<0.05$).

CONCLUSION

T1 mapping is an alternative sequence for the evaluation of diffuse myocardial fibrosis in DM patients. Myocardial fibrosis is correlated with circumferential peak diastolic strain rate in DM patients.

CLINICAL RELEVANCE/APPLICATION

(dealing with T1 mapping imaging and cardiac MRI strain) ' T1 mapping is an alternative sequence for the evaluation of diffuse myocardial fibrosis in DM patients.'

SSQ03-06 Subclinical Left Ventricle Dysfunction in Diabetes Mellitus Patient: Assessed by Cardiac MRI Strain Analysis

Thursday, Nov. 30 11:20AM - 11:30AM Room: S504AB

Participants
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PURPOSE

Cardiovascular disease is the key cause of mortality of diabetes mellitus (DM), for which in-time detection of dysfunction and early intervention can significantly improve the prognosis. The aim of this study is to evaluate the subclinical left ventricle (LV) dysfunction in DM patient and whether the patient with good glycemic control have decreased cardiac function with time using cardiac magnetic resonance (CMR) strain analysis.

METHOD AND MATERIALS

In total, 23 DM patients with normal LVEF, including 13 patients diagnosed not more than 10 years and 10 patients diagnosed more than 10 years, and 25 healthy subjects, underwent CMR examination. LV global myocardial strain parameters including peak strain, peak systolic strain rate and peak diastolic strain rate, as well as global radial, circumferential and longitudinal analysis were calculated and compared among the three patient groups.

RESULTS

DM group had a significantly lower longitudinal peak strain (-15.32 ± 5.18 vs. -19.53 ± 2.76, $p=0.007$) and peak diastolic strain rate (1.22 ± 0.29 vs.1.50± 0.28, $p=0.000$), circumferential peak diastolic strain rate (1.20 ± 0.39 vs. 1.50 ± 0.26, $p=0.000$), and higher radial peak systolic strain (2.59 ± 0.81 vs. 2.0 ± 0.61, $p=0.033$) compared with the normal subjects. The DM patient diagnosed more than 10 years have lower peak systolic strain rate [radial (2.03 ± 0.52 vs. 2.61 ± 0.77, $p < 0.000$), circumferential (-0.89 ± 0.19 vs. -1.02 ± 0.20, $p < 0.000$) and longitudinal (-0.79 ± 0.11 vs. -0.97 ± 0.13, $p < 0.000$), respectively], lower radial peak strain (38.18 ± 9.89 vs. 43.47 ± 10.88, $p < 0.000$) and lower circumferential peak diastolic strain rate(1.01 ± 0.26 vs. 1.24 ± 0.21, $p = 0.004$) compared with diagnosed not more than 10 years.

CONCLUSION

Cardiac MRI strain is sensitive to early dysfunctional of heart, which might help with better management for the DM patients with

normal LVEF. Moreover, the cardiac function is gradually reduced with time, even though the blood glucose controlled well, especially the systolic function.

CLINICAL RELEVANCE/APPLICATION

Cardiac MRI strain is sensitive to early dysfunctional change of DM patients than traditional heart function evaluation parameters, which might help with better management for the DM patients with normal LVEF

SSQ03-07 Aortic Stiffness, Myocardial Fibrosis, Left Ventricular Strain and Epicardial Fat in Hypertension and Diabetes Mellitus

Thursday, Nov. 30 11:30AM - 11:40AM Room: S504AB

Participants
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PURPOSE

A combined assessment of aortic stiffness, left ventricular (LV) fibrosis, LV strain and epicardial fat volume (EFV) may decrease risk in patients with cardiovascular risk factors such as hypertension (HTN) or diabetes mellitus (DM). Using a MRI approach these parameters were assessed in 63 patients and related to the presence of HTN and DM.

METHOD AND MATERIALS

20 healthy controls (57.2±8.2years[y]; 26.2±3.9kg/m²), 31 hypertensive patients without DM (HTN-Pts; 59.6±6.7y; 28.4±4.7kg/m²) and 12 with DM (DM-Pts; 58.8±9.9y; 30.7±6.3kg/m²) were examined at 1.5Tesla. No patients had coronary artery disease; all patients had a normal LV ejection fraction. Aortic stiffness was evaluated by velocity encoded MRI to determine pulse wave velocity (PWV) of the aortic arch (Fig. A), EFV by a 3D-Dixon sequence with acquisition of fat-only images and fat-fraction maps (Fig. B&C), LV T1 relaxation times (T1) to detect fibrosis using a MOLLI scheme, and, longitudinal & circumferential systolic strain (LS; CS) by feature tracking software.

RESULTS

Age and gender did not differ significantly; BMI was higher in DM-PTs compared to controls. Results were adjusted for BMI. EFV was highest in DM-PTs followed by HTN-PTs and controls (EFV = 78.4±28.0 vs. 64.2±27.3 vs. 50.3±22.7ml/m²; $P<0.05$). T1 was higher in DM-PTs and HTN-PTs than in controls (T1 = 994.0±43.2 resp. 991.6±35.5 vs. 964.6±40.3ms; $P<0.05$). PWV was significantly higher in DM-PTs and LV strain lower compared to HTN-PTs and controls (PWV = 9.8±3.3 vs. 8.6±1.7 resp. 8.1±1.9m/s; LS = -20.9±5.1 vs. -24.7±4.6 resp. -25.5±3.8%; CS = -24.4±5.7 vs. -27.1±5.0 resp. -28.3±4.1%). Fig. D illustrates a healthy male with a lower T1 compared to a HTN-Pt (Fig. E) and Fig. F with a higher LS compared to a DM-PT.

CONCLUSION

Hypertension and diabetes mellitus are associated with LV fibrosis; cardiac remodeling as well as metabolic and inflammatory mechanisms of an increased EFV may play a role. EFV and aortic stiffness are further increased and LV strain reduced in DM-PTs possibly due to an increased metabolic and inflammatory burden associated with DM. A multi-parameteric assessment of these parameters can easily be integrated into a routine MRI exam and may be supportive for a more accurate cardiovascular risk evaluation.

CLINICAL RELEVANCE/APPLICATION

MRI is an accurate tool for evaluation of cardiovascular risk and prognostic parameters in patients with risk factors, such as hypertension or diabetes mellitus.

SSQ03-08 Strain of Ascending Aorta on Cardiac Magnetic Resonance in 1,027 Patients: Relation with Age, Gender, and Cardiovascular Disease

Thursday, Nov. 30 11:40AM - 11:50AM Room: S504AB

Participants
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PURPOSE

To evaluate aortic strain (AS) with cardiac magnetic resonance (CMR) in a large series of consecutive patients with different cardiovascular diseases (CVDs).

METHOD AND MATERIALS

Two-dimensional phase-contrast gradient-echo sequences of the ascending aorta were retrospectively selected in 1,027 patients (726 males, 301 females). In all images, aortic lumen area was segmented using a semi-automatic approach to calculate AS values. Subgroup analysis was performed for patient with normal CMR, Tetralogy of Fallot (ToF), and ischemic heart disease (IHD). Multivariate and post-hoc analyses were performed to evaluate the effect of age, gender and CVDs on AS values. In order to consider also the age factor, the subjects were grouped into 7 age bins of 10 years (0-9, 10-19, 20-29, 30-39, 40-49, 50-59 and >= 60 years).

RESULTS

Taking into account the whole sample, the AS resulted inversely correlated with age ($\rho = -0.51$, $P<.001$). Multivariate analysis showed significant differences in AS among decades of age ($P<.001$), genders ($P=.007$) and CVD subgroups ($P<.001$) without interaction among these factors. Post-hoc analysis showed significantly lower AS in ToF and IHD patients compared to subjects with normal CMR (P<.001). Gender-related differences were significant in ToF subjects ($P=.008$), in particular men with ToF showed a lower AS when compared with men with normal CMR ($P=.005$). In IHD patient, AS was lower compared to normal CMR subjects (men: $P<.001$, women: $P=.016$), without significant difference between genders ($P=.732$). Aortic strain reduction during aging was observed in all CVD groups.

CONCLUSION

Differences in age, gender, and CVD independently affect AS. The lower AS observed in ToF fosters its assessment during follow-up in adulthood. The gender-related difference gives the basis for future studies focused on its possible causes and clinical implications. Nevertheless, further investigations on elderly patients and, in particular, in adults with congenital heart disease are advised.

CLINICAL RELEVANCE/APPLICATION

Our results showed that age, gender, and CVDs independently affect the ascending AS, highlighting the importance of its follow-up assessment, especially in patients with congenital cardiac diseases.

SSQ03-09 Effectiveness of Multiparametric Structure-Function Cardiac MRI in Detection of Acute Cardiac Allograft Rejection

Thursday, Nov. 30 11:50AM - 12:00PM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

Acute cardiac allograft rejection (ACAR) is a leading cause of morbidity and mortality in heart transplant (Tx) recipients. Non-invasive screening with cardiac magnetic resonance imaging (CMR) is promising given its ability for comprehensive characterization of acute myocardial injury and subtle left ventricular (LV) structural and functional changes. We hypothesized that CMR-derived T2, T1, extracellular volume fraction (ECV), and LV velocities will differ between 1) healthy controls and Tx recipients without history of ACAR and 2) Tx recipients with and without current evidence of ACAR.

METHOD AND MATERIALS

CMR at 1.5T (Magnetom Aera/Avanto, Siemens, Erlangen, Germany) was performed prospectively on 76 Tx recipients (49.9±15.9 yrs, 45% female) and 14 controls (47.7±16.7 yrs, 36% female) for 131 total studies. Analyses were stratified based on myocardial biopsy grade: Controls (N=14), No ACAR (no history of ACAR, N=68), Past ACAR (history of ACAR, N=34), ACAR+ (active grade>=1R ACAR, N=15). CMR included T2-mapping, pre- and post- contrast T1-mapping (to calculate ECV), and tissue phase mapping (TPM; to generate myocardial velocities).

RESULTS

T2 was significantly higher in No ACAR patients compared to controls (49.4±3.4 ms vs. 45.2±2.3 ms, P<0.01). Compared to No ACAR patients, patients with Past ACAR (51.7±4.1 ms vs. 49.4±3.4 ms, P<0.01) or current ACAR+ (53.8±4.9 ms vs. 49.4±3.4 ms,

P<0.01) had greater T2 values. ECV was significantly elevated in ACAR+ patients compared to recipients without ACAR (31.6±3.6% vs. 26.7±3.2%, P<0.01) regardless of history of ACAR (No ACAR and Past ACAR). ROC analysis for the detection of ACAR+ revealed AUC of 0.80 and 0.85 for T2 and ECV respectively. TPM identified lower peak systolic longitudinal velocities and higher peak diastolic radial velocities in No ACAR patients compared to controls (2.8±1.0 cm/s vs. 4.9±1.1 cm/s, P<0.01; -3.7±0.8 cm/s vs. -2.9±0.7 cm/s, P<0.01).

CONCLUSION

CMR parameters are sensitive to structural and functional change in Tx recipients. T2 and ECV are effective at detecting ACAR, supporting further development of CMR for ongoing surveillance post Tx.

CLINICAL RELEVANCE/APPLICATION

CMR-derived T2 and ECV are effective in detecting acute cardiac allograft rejection (ACAR) following heart transplant, promoting use of multiparametric CMR as an alternative ACAR screening tool.

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SSQ04

Chest (Interventional/Ablation)

Thursday, Nov. 30 10:30AM - 12:00PM Room: E351

CH CT IR MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Steven Y. Huang, MD, Houston, TX (*Moderator*) Scientific Advisory Board, Adient Medical Inc

Sub-Events

SSQ04-01 Analysis of Risk Factors for Hemoptysis after Percutaneous Transthoracic Needle Biopsies in 4,172 Cases: Focusing on the Effects of Diametrical Enlargement of the Main Pulmonary Artery

Thursday, Nov. 30 10:30AM - 10:40AM Room: E351

Participants
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PURPOSE

To evaluate risk factors for hemoptysis after cone-beam computed tomography (CBCT)-guided percutaneous transthoracic needle biopsy (PTNB) and, in particular, to determine whether the enlargement of main pulmonary artery diameter (mPAD) is a risk factor for PTNB-related hemoptysis.

METHOD AND MATERIALS

After approval from the Institutional Review Board, 4,172 cases of CBCT-guided PTNBs in 3,840 patients (2299 men and 1541 women; mean age, 63.64 years, ranging from 7-to-94 years) were retrospectively included in this study. Various clinical, radiological, and biopsy-related data including mPAD were evaluated using univariate and multivariate logistic regression analyses to figure out significant risk factors for both hemoptysis and severe hemoptysis. Severe hemoptysis was designated when blood transfusion, vascular embolization, or cardiopulmonary resuscitation were required to manage patients with the diagnosis.

RESULTS

Hemoptysis occurred in 5.78% (n=241) of all PTNB procedures, while severe hemoptysis occurred in 0.18% (n=7). Female sex (Odds ratio [OR]=2.703, P<0.001), history of anti-platelet or anti-coagulative drugs (OR=2.362, P=0.002), prolonged activated partial thromboplastin time (OR=1.951, P=0.042), subsolid nodules (OR=3.529, P<0.001), cavitary nodules (OR=3.205, P=0.038), and long pleura-to-target distance (P<0.001) were independent risk factors for hemoptysis, while mPAD enlargement was not a significant risk factor. Regarding severe hemoptysis, however, mPAD enlargement (OR=5.004, P=0.037) was a significant independent risk factor in combination with subsolid (OR=6.648, P=0.046) and cavitary target nodules (OR=20.284, P=0.008).

CONCLUSION

mPAD enlargement was not a significant risk factor for PTNB-related hemoptysis. However, it was a significant risk factor for severe PTNB-related hemoptysis.

CLINICAL RELEVANCE/APPLICATION

mPAD enlargement was a significant risk factor for severe PTNB-related hemoptysis, along with subsolid and cavitary nodule features.

SSQ04-02 Active Targeting Theranostic Iron Oxide Nanoparticles for MRI and Magnetic Resonance-Guided Focused Ultrasound Ablation of Lung Cancer

Thursday, Nov. 30 10:40AM - 10:50AM Room: E351

Participants
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PURPOSE

To evaluate an active targeting and nano-sized SPIO platform for the enhancement of imaging sensitivity and tumor-ablative efficacy in MRgFUS, and applications of a series of MRI approaches for non-invasive monitoring treatment response were demonstrated using nude rat lung tumor models.

METHOD AND MATERIALS

PEGylated SPIO nanoparticles was further decorated with high affinity anti-EGFR monoclonal antibody to form a nanocomposite (anti-EGFR-PEG-SPIO) , and in vitro and vivo MRI was preformed. 24 rats were then randomly divided into positive control group (n=6), negative control group (n=6), PEGylated SPIO group (n=6), and anti-EPS group (n=6). The nude rats tumors were sonicated after injection of the PEGylated SPIO and anti-EPS solution (1ml) via tail vein at 4.0 h. Prior to sonication, T2W SE were acquired. For each nude rat, two to five sonications were planned. The treated areas were about 0.5 cm2 according to the pretreatment plan. Each dynamic temperature was monitored by real-time MRI temperature mapping of the treated area.

RESULTS

The T2 values for the anti-EGFR-PEG-SPIO and PEGylated SPIO contrast agents at 3.0 T MRI were 10.3ms and 11.2ms, respectively. T2 relativity values were 97.1 s-1mM-1 and 89.3 s-1mM-1, respectively.The T2 SI in targeting group decreased significantly compared with non-targeting group. The rate of SI change was -58.2%, -82.7%, -94.4%, and 98.3% respectively, at the iron concentrations. Thirty minutes after the injection of anti-EPS, the T2 SNR in the lung tumor started to decrease. The T2 SNR at the tumor region decreased more significantly at 4 hours post-injection of anti-EPS compared with the nontargeting group ($p<0.01$). The energy of the targeting group was even lower than that of the control (low enegy) group (32W vs 54 W, $P<0.01$) ,Peak temperature significantly higher than control group. T2W SI and ADC significantly after ablation higher than before ablation in targeting, and nontargeting, control group

CONCLUSION

We have successfully developed anti-EGFR modified PEGyloated SPIO nanoparticles as targeted MR imaging contrast agents and the synergistic agents for MRgFUS lung carcinoma thermotherapy. After tumor ablation, tumor therapeutic efficiency monitored by the clinical MRI equipment can be applied as an attractive potential noninvasive strategy.

CLINICAL RELEVANCE/APPLICATION

Applications of a series of MRI approaches can be applied as an attractive potential noninvasive strategy.

SSQ04-03 Non-Diagnostic CT-Guided Percutaneous Needle Biopsy (PTNB): Predictive Factors and Final Diagnoses

Thursday, Nov. 30 10:50AM - 11:00AM Room: E351

Participants
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PURPOSE

To investigate the final diagnosis of pulmonary lesions with an initial non-diagnostic result on CT-guided percutaneous transthoracic needle biopsy (PTNB) and the predictive factors for a non-diagnostic result.

METHOD AND MATERIALS

All PTNB performed over a 4-year period were retrospectively reviewed. The initial pathological results were classified into 3 categories as malignant or suspicious for malignant, benign specific, and non-diagnostic. The demographic data of patients, lesion characteristics, technique, complications, initial pathological results and final diagnosis were reviewed. Statistical analysis was performed using Pearson's X2 test or Fisher's exact test.

RESULTS

Out of a total of 894 consecutive biopsies, 690 (77.2%) were positive or suspicious for malignancy, 55 (6.2%) were specific benign, and 149 (16.7%) were non-diagnostic. Significantly higher non-diagnostic rates were found in cases where the lesion was less than 15mm, the needle tract traversed emphysema, the introducer needle was outside the lesion, total time was greater than 60 minutes and when alveolar hemorrhage was present during the procedure. 122 of 149 non-diagnostic cases had a subsequent diagnosis made by repeat biopsy, surgery or follow-up; and malignancy was confirmed in 44 cases (44/122, 36%). There were statistically significant differences in non-diagnostic biopsy rates for patients with malignant lesions (44/734, 6%) and benign lesions (78/133, 59%) ($p=0.001$). In the non-diagnostic group, patients with history of prior malignancy and patients with atypical cells present in the initial pathological report were more likely to have a final diagnosis of malignancy ($p=0.043$ and $p=0.001$, respectively)..

CONCLUSION

The predictive factors for non-diagnostic results were lesion size less than 15mm, needle tract traversing emphysema, introducer needle outside the lesion, procedure time greater than 60 minutes, presence of alveolar hemorrhage, and a final benign diagnosis. Although the majority of the non-diagnostic cases yielded a benign diagnosis, 36% were malignant. In cases with a history of malignancy or the presence of atypical cells in the biopsy sample repeat biopsy or surgical resection should be considered.

CLINICAL RELEVANCE/APPLICATION

The management of a non-diagnostic PTNB result is difficult, however, the 36% rate of malignancy in this group underscores the need for further diagnostic evaluation in these patients.

SSQ04-04 Evaluation of Rabbit Lung VX2 Tumor after Radiofrequency Ablation by Multi-B Value Based MR Diffusion Weighted Imaging

Thursday, Nov. 30 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

To explore the multi-b value based diffusion weighted imaging (DWI) on evaluation of lung VX2 tumor after radiofrequency ablation (RFA).

METHOD AND MATERIALS

Fifty-three lung VX2 tumor models were examined by multi-b value DWI (b=0,10,20,50,100,150,200,500,800, 1000,2000 s/mm2) at 1 day before RFA, and 1, 3, 7, 14 days after RFA. Both mono-exponential and bi-exponential model (including intravoxel incoherent motion imaging, diffusion kurtosis imaging (DKI) and stretched exponential model (SEM)) were used to calculate corresponding parameters (ADC, D, D*, f, Dk, K, DDC and A) based on ROIs of the maximal cross-sectional tumor before and after RFA by two thoracic radiologists, blindly. The parameters were compared between pre-RFA and post-RFA groups; the complete and incomplete RFA groups based on H&E and TUNEL staining, and correlated with MVD. The t test, Wilcoxon test, or Mann-Whitney U test was used in two-group comparisons. The area under curve (AUC) was used to assess the diagnostic performance. The Spearman correlation was used to analyze the correlation. Bland-Altman method was used to assess the intraobserver repeatability, and the coefficient of variation (CV) <5% was in good repeatability.

RESULTS

ADC, D, Dk, DDC and a values increased after RFA (all p<0.02), while K values decreased at day 3 and day 7, postoperatively (p=0.03; 0.01). ΔADC, ΔD, ΔDk, ΔDDC, Δa and ΔK of the complete RFA group was higher than that of the incomplete RFA group (all p<0.03) at day3; day7; day1-14; day7; day7 and day3, postoperatively, respectively, and the AUC of ΔADC>=0.44×10-3mm2/s; ΔD>=0.18×10-3mm2/s; ΔDk>=0.50, 0.37, 0.19 and 0.19×10-3mm2/s; ΔDDC>=0.16 × 10-3mm2/s; Δa>=0.05; ΔK>=0.23 in determination of tumor with complete ablation, was 0.93; 1.00; 1.00, 0.98, 1.00 and 0.96; 0.88; 0.88; 0.95, respectively. No difference of D*and f value changes was noticed, postoperatively (all P value>0.09). No difference of AUC and no correlation of parameters with MVD (all P values > 0.05). The CV of ADC, DDC, a, Dk, K and D at baseline was 2.18%, 3.33%, 3.45%, 7.18%, 8.65% and 18.62 %, respectively.

CONCLUSION

DKI could be used to evaluate the efficacy of RFA at day 1, postoperatively; ADC (b = 0, 500s/mm2) and DKI could be utilized to evaluate it at day 3, postoperatively; both the DKI and SEM-DWI could evaluate it at day 7 and day 14, postoperatively.

CLINICAL RELEVANCE/APPLICATION

DKI and ADC could be used to early assess the lung tumor after RFA.

SSQ04-05 Risk of Pleural Recurrence after Percutaneous Transthoracic Needle Biopsy in Stage I Non-Small Cell Lung Cancer: A Large Center Experience

Thursday, Nov. 30 11:10AM - 11:20AM Room: E351

Participants
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PURPOSE

To determine whether percutaneous transthoracic needle biopsy (PTNB) increase the risk of (a) isolated pleural recurrence and (b) concomitant pleural seeding and metastasis in stage I non-small cell lung cancer (NSCLC).

METHOD AND MATERIALS

In this institutional review board-approved retrospective study, medical records of total of 830 consecutive patients with stage I NSCLC who underwent curative resection between 2004 and 2010 were reviewed. Median duration of follow-up was 1843 days (interquartile range, 1006-2734). Multiple logistic regression analyses were performed to identify risk factors of pleural recurrence.

RESULTS

Of 830 patients, 540 patients (65.1%) underwent PTNB before surgery, while 290 patients (34.9%) underwent non-PTNB procedures including bronchoscopic biopsy or exploratory thoracotomy. An isolated pleural recurrence was found in 26 patients (3.1%, [95%CI, 2.1-4.6%]) (20 in PTNB group, 6 in non-PTNB group). There was no significant association between PTNB and isolated pleural recurrence (P=0.197). Concomitant pleural recurrence occurred in 42 patients (5.1%, [95%CI, 3.8-6.8%]) (34 in PTNB group, and 8 in non-PTNB group). Subpleural location (p=0.007), tumor consistency (solid, part-solid, nonsolid) (p=0.046), PTNB (p=0.027), pathologic T stage (p<0.001), microscopic pleural invasion (p<0.001) and microscopic lymphatic invasion

(p=0.019) were associated with concomitant pleural recurrence. The most significant factor of pleural recurrence was only microscopic pleural invasion (Odds Ratio, 4.28; 95% CI, 2.20 to 8.29) (P<0.001) on multiple logistic analysis. Among 540 patients undergoing PTNB, transfissural approach did not have significant association with pleural recurrence (P=0.220), while the most sole significant factor was microscopic pleural invasion (Odds Ratio, 3.40; 95% CI, 1.54 to 7.51) (P=0.002).

CONCLUSION

PTNB did not increase the risk of isolated or concomitant pleural recurrence in early stage NSCLC. Higher incidence of concomitant pleural seeding in PTNB group was presumably attributed to peripheral lung cancer, potentially accompanying microscopic pleural invasion.

CLINICAL RELEVANCE/APPLICATION

PTNB can be performed for confirmatory diagnosis of early stage lung cancer without raising the risk of isolated or concomitant pleural recurrence.

SSQ04-06 Genomic Profiling of Non-Small Cell Lung Cancer (NSCLC) for Personalized Therapy

Thursday, Nov. 30 11:20AM - 11:30AM Room: E351

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PURPOSE

Genomic profiling for personalized targeted therapy is emerging for NSCLC. Systematic testing for mutations in BRAF, ERBB2, PIK3CA and ALK translocations, in addition to EGFR and KRAS was introduced in our institution in July 2009. We report the utility, efficacy and safety of CT guided trans-thoracic needle biopsy (TTNB) in this cohort.

METHOD AND MATERIALS

Patients with stage IV/relapsed NSCLC who underwent CT guided TTNB to identify driver mutations prior to therapy were reviewed. Pathology specimens were evaluated for tumor adequacy, then manually dissected and analyzed by a variety of methods, including next generation sequencing for mutations in selected exons of EGFR, KRAS, BRAF, PIK3CA and ERBB2. ALK rearrangements were detected with fluorescence in-situ hybridization (FISH) and/or immunohistochemistry. Complications (pneumothorax, hemorrhage and admission) were recorded.

RESULTS

Between 6/12/2009 and 12/30/2016, 764 patients with NSCLC underwent TTNB. The median age was 67 years. 454(59%) were female, 426(56%) were former/current smokers and 580(75%) had stage IIIB/IV disease. 492(64%) of all TTNB performed were profiled for genomic analysis, of which 426(87%) had sufficient tissue on core biopsies for genomic profiling; 75(10%) of the 492 patients failed analysis for ALK rearrangements due to less than 50 tumor cells on the hybridized slide. The number of samples obtained ranged from 1-10 (2 cm 18-20G). Lesions biopsied ranged in size from 0.6-9.9 cm. PET guidance was used in 323(42%) patients. Targetable alterations were identified in 172/426(40%) patients (EGFR:139(18%); KRAS:101(13%);ALK:10(1%);BRAF:9(1%)). 216(28%) had pneumothoraces:137(<10% in size), 42 (10-30%) and 37(>30%). 79(10%) were admitted post procedure. 85(11%) had pulmonary hemorrhage. There was no statistically significant difference in pneumothorax rate by needle size (p=0.8). Pneumothorax rate significantly correlated with distance from the pleura and emphysema. Treatment strategy was changed in 183(24%) patients based on the biopsy result.

CONCLUSION

CT guided TTNB is a feasible, safe and efficacious technique for genomic profiling for targeted therapy, enabling the acquisition of sufficient tissue for gene mutation analyses.

CLINICAL RELEVANCE/APPLICATION

Personalized medicine has increased the need for rebiopsy in NSCLC; the ability to acquire sufficient tissue with minimal morbidity will help design clinical trials and inform management decisions.

SSQ04-07 Repeat Biopsy for the Patients with Acquired Resistance to EGFR TKIs: Implication of Biopsy-related Factors on Detection of T790M Mutation

Thursday, Nov. 30 11:30AM - 11:40AM Room: E351

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PURPOSE

Identification of T790M resistance mutation through repeat biopsy is essential to determine eligibility of the potential candidate patients for the third-generation epidermal growth factor receptor (EGFR) tyrosine kinase inhibitors (TKIs). We aimed to investigate predictors for the successful repeat biopsy specimen acquisition for mutational analysis and T790M mutation detection.

METHOD AND MATERIALS

We retrospectively reviewed 90 advanced non-small cell lung cancer patients harboring EGFR mutation who underwent repeat cone-beam CT-guided transthoracic needle biopsy. Clinical characteristics as well as repeat biopsy-related factors were compared between the patients with and without adequate biopsy specimen acquisition and between the patients with and without T790M mutation. After univariate analysis, multivariate logistic regression analysis was performed to reveal independent predictors.

RESULTS

Appropriate biopsy specimen was obtained in 90% (81/90) and T790M mutation was found in 61.7% (50/81) of the study population. None of the analyzed variables was significantly associated with successful biopsy specimen acquisition. For the T790M mutation detection, duration of EGFR TKI treatment (P=0.066), duration of total chemotherapy treatment (P=0.026), tumor size (P=0.066), and metastatic lesion as a biopsy target (P=0.029) showed P values less than 0.10. Multivariate analysis revealed that smaller target tumor size (odds ratio, 0.765; 95% confidence interval: 0.600, 0.975; P=0.031) and metastatic lesion as a biopsy target (odds ratio, 4.194; 95% confidence interval: 0.997, 17.637; P=0.050) were significant independent predictors of T790M mutation detection.

CONCLUSION

Detection of T790M mutation at repeat biopsy was associated with smaller target tumor size and selection of metastatic lesion as a biopsy target.

CLINICAL RELEVANCE/APPLICATION

Selection of biopsy target can affect detection of T790M mutation in in patients undergoing repeat biopsy (PTNB) as candidates of third-generation EGFR TKIs.

SSQ04-08 Single Institution Experience in Pre-Operative Pulmonary Lesion Marking Using Fiducial Markers and Micro-Coils in Preparation for Fluoroscopic Wedge Resection: Rates of Success, Complications, and Comparison of Two Labeling Devices

Thursday, Nov. 30 11:40AM - 11:50AM Room: E351

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PURPOSE

Evaluate the use of either Fiducial Marker (FM) or Microcoils (MC) to aid image-assisted wedge surgical resection of small pulmonary nodules and explore associations between patient/nodule characteristics and development of complications.

METHOD AND MATERIALS

IRB approved , HIPAA compliant database search identified patients who had CT-guided FM or MC implantation for wedge resection of pulmonary nodules from 01/01/95 - 01/22/2016. EMR was searched to extract patient's demographics including age, gender and body mass index. CT images prior to FM/MC insertion were reviewed by a single radiologist for nodule characteristics including size, location and depth. Post procedure CT images were read to measure distance of FM/MC to the nodule and to assess for complications including hemorrhage, pneumothorax and marker migration. Chi squared analysis at <0.05 was used to explore asssociations between patient/nodule characteristics and the development of complications.

RESULTS

We identified 136 nodules in 127 patients (67M:60F). Preoperatively, 130 FMs and 33 MCs were inserted to aid wedge resection in 112 and 15 patients respectively. 97% [124/127] of patients had successful same day resection as planned, two were delayed due to complications and a single patient needed a lobectomy due to lesion location. 68% of patiebnts [88/127] had complications following FM/MC insertion including hemorrhage [32%], pneumothorax [24%], a combination of hemmorhage and pneumothorax [9%] and marker moigration/emolization [3%]. Depth of lesion from skin was significantly associated with developing a complication. No other patient of nodular characteristic was associated with developing a complication. We observed a smaller percentage of patient complications in MC as compared to FM placement and these were of less severity, although statistical significance was not reached (p=0.06)

CONCLUSION

CT-guided pulmonary marking of pulmonary lesions is effective at aiding wedge resection. Complications are relatively common but mild with no significant effect on patient clinical management. Use of MC rather than FM may improve the saftey profile of lesion marking.

CLINICAL RELEVANCE/APPLICATION

Mild complications are relatively frequent but shoiuld not deter FM or MC placement for wedge resection of pulmonary nodules. Our

data suggests MC may have a better safety profile as compared to FM.

SSQ04-09 Rebiopsy of Non-Small Cell Lung Cancer with Acquired Resistance to EGFR Tyrosine Kinase Inhibitor: Clinical and CT Characteristics of Patients with T790M Mutation

Thursday, Nov. 30 11:50AM - 12:00PM Room: E351

Awards
Student Travel Stipend Award

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PURPOSE

Re-biopsy for T790M mutation analysis of non-small cell lung cancer (NSCLC) after EGFR-tyrosine kinase inhibitor (TKI) treatment failure is important to determine further chemotherapy regimen. However, little is known regarding the clinical and radiologic differences among patients with or without T790 mutation.

METHOD AND MATERIALS

Between Jan 2011 and Jan 2017, 370 lung cancer patients underwent re-biopsy after TKI failure, and among them, 362 were assessed with adequate specimen. Clinical course, serial CT scans and pathologic reports were retrospectively reviewed. Re-biopsy methods are varied: CT or fluoroscopy-guided lung biopsy (n=130), EBUS or BFS-guided (n=71) biopsies, US-guided lymph node (n=40) or liver (n=20) biopsy, pleura biopsy (n=9), other sites (n=48) biopsies including surgical lung resection and pleural fluid analysis (n=44). CT scans obtained at the time of initial diagnosis and re-biopsy were compared between patients with and without T790M mutation.

RESULTS

Among 362 patients, 150 (41.4%) presented T790M mutation on re-biopsy. Two patients who were negative T790M mutation on pleural fluid analysis finally diagnosed as positive T790M mutation by following CT-guided biopsy or surgical lung resection. Mean interval between initial TKI failure and rebiopsy was longer in T790M positive group than negative group (p=0.01). On initial CT, the presence of pleural metastasis was significantly higher in T790M positive group (p=0.006). On CT obtained at the time of rebiopsy, pleural retraction adjacent to primary lung cancer and pleural metastasis were significantly noted, and number of metastatic sites is also higher in patients with positive T790M mutation ($p < 0.01$).

CONCLUSION

T790M mutation may be related to the interval between initial TKI failure and rebiopsy. Pleural retraction adjacent to primary lung cancer and pleural metastasis on CT at the time of rebiopsy were significantly associated factors to positive T790M mutation in NSCLC patients with TKI failure.

CLINICAL RELEVANCE/APPLICATION

On CT at the time of rebiopsy, pleural retraction and pleural metastasis were significantly noted in patients with positive T790M mutation after TKI failure. Negative T790M on pleural fluid analysis could not give a guarantee for true negative, and further core biopsy might be recommended.

SSQ05

Chest (Lung Cancer Screening)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S402AB

CH CT OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSQ05-01 Performance of Deep Learning Model in Detecting T1 Lung Cancer with Chest Radiographs

Thursday, Nov. 30 10:30AM - 10:40AM Room: S402AB

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PURPOSE

The conventional chest radiograph (CXR) is one of the most widely available modality, but detecting small nodules on CXR remains a demanding task for radiologists. The purpose of this study was to evaluate diagnostic performance of deep convolutional neural network model (Deep learning model, DLM) for detecting a T1 lung cancer.

METHOD AND MATERIALS

For the training set, we collected CXRs from 19,927 individuals at our hospital (M:F = 11,082:8,845; mean age, 55 yrs) including 14,579 normal subjects and 5,348 patients with CT proven lung nodules. We adopted an augmented training method to create a training set of 280,000 images, then developed and trained DLM using a 50-layer deep residual network. For the test set, we collected 2,509 consecutive patients with a surgically-proven T1 lung cancer (M:F = 1,167:1,347; mean age, 60 yrs) between years 2010 and 2015. Inadequate cases (e.g., missing presurgical CXR, long interval between CT and CXR, nodules < 10 mm) were excluded. Two expert radiologists, who reached decisions by consensus, marked and scored nodule visibility on CXR on four levels: 1 (invisible) ~ 4 (obvious). The final test set included 1,483 patients with a lung nodule >= 10 mm. For human observer study, we selected 200 patients from the test set (100 with a nodule of subtlety 3 and 100 with subtlety 4) and 300 matching normal images. Six radiologists (experience of CXR reading ranging from 4 to 21 years) participated as observers. The radiologists marked lesion candidates and scored the confidence of nodule presence from 1 to 10. The detection performance of DLM and observers were evaluated using FROC analysis.

RESULTS

DLM showed sensitivities of 75% for all T1 lung cancers and 88% for subtlety levels 3 and 4, respectively at FPPI 0.3. When compared with human observers, DLM showed sensitivity 82.5% at FPPI 0.1 and 88% at FPPI 0.3. Observers showed mean sensitivity 78% (68 ~ 83%) at FPPI 0.1 and 85% (80 ~ 89%) at FPPI 0.3. Observers showed mean AUC 0.819 (0.754 ~ 0.862) in the FPPI range from 0.03 to 0.44, while DLM showed AUC of 0.858 in the same FPPI range.

CONCLUSION

A DLM developed for the detection of lung nodules on CXR yields high diagnostic performance in detecting T1 lung cancers.

CLINICAL RELEVANCE/APPLICATION

A diagnostic system based on a deep learning model shows promise for the future development of a CR-based, mass screening device for lung cancer identification.

SSQ05-02 Extrapulmonary Malignancy as a Cause of Death in the CT Arm of the National Lung Screening Trial: A Retrospective Analysis of CT Evidence of Disease

Thursday, Nov. 30 10:40AM - 10:50AM Room: S402AB

Participants

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PURPOSE

To explore CT findings associated with "other neoplasms", which were the cause of death (COD) in 22% of deaths in the National Lung Screening Trial (NLST).

METHOD AND MATERIALS

Three board-certified cardiopulmonary radiologists retrospectively reviewed low-dose screening CTs of the 263 NLST participants whose CODs were one of the 10 most common extrapulmonary malignancies (EPM), either on the death certificate or in the endpoint verification process, and in whom CT images were available. Two readers each reviewed ½ the cases, and a 3rd reader reviewed all 263 cases. The readers were aware of COD in each case. The scans were classified as negative, indeterminate or positive for findings that could be correlated with the EPM listed as the COD. For discrepant reads, the case was reviewed by all three readers to develop a consensus opinion.

RESULTS

The most common EPMs to cause death in the CT arm of the NLST population were pancreas (N = 76), esophagus (N = 35), colorectal (N = 34), brain (N = 21), leukemia (N = 21), bladder (N=19), liver (N = 18), breast (N=14), multiple myeloma (N=13) and lymphoma (N = 12). Of these, the CT scans were positive for EPMs with visualization of the primary tumor or metastatic disease in 15.6% (41/263) of cases. The EPMs that were most likely to be detected on the CT were esophageal (37.1%, 13/35), breast (35.7%, 5/14) and pancreatic (13.1%, 10/76) cancers. In all three tumors, the primary tumor was visible as a solid mass. In colorectal cancer, however, the disease was detected as metastatic to the liver in 11.8% (4/34) cases. The CT scans were classified as indeterminate for detection of the primary malignancy or metastasis in an additional 9.9% (26/263) of cases, but the findings could potentially have prompted additional work-up ultimately leading to the detection of the EPM.

CONCLUSION

Extrapulmonary malignancy is the third most common cause of death in the lung cancer screening population. Findings related to the primary tumor or metastatic disease are present in 15.6% of the most common tumors. The primary tumor was most likely to be seen in esophageal, breast and pancreatic cancers, and appeared as a solid mass.

CLINICAL RELEVANCE/APPLICATION

Detection of an EPM on lung cancer screening CT may help reduce mortality in this high risk population. Esophageal, breast and pancreatic cancers may be visible as solid masses.

SSQ05-03 Outcome of Lung-RADS Category 3 and 4 on Initial Lung Cancer Screening Exams

Thursday, Nov. 30 10:50AM - 11:00AM Room: S402AB

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PURPOSE

To determine the follow-up course and clinical outcome of lung cancer screening exams for patients whose studies were designated as Lung-RADS category 3 and 4 on the initial screening exam.

METHOD AND MATERIALS

The reports of all initial lung cancer screening chest CT exams performed at a major tertiary center between 2/1/2013 and 12/31/2016 were reviewed. Detailed chart review was performed for all patients assigned as category 3 and 4, including reports of any subsequent imaging, diagnostic procedures and complications, pathology and microbiology. We compared our findings with those estimated and predicted by ACR Lung-RADS version 1.0.

RESULTS

Our IRB approved study included 1567 adult patients (M:F 826:741, Age:64±6) and identified 20% (317/1567) exams as Lung-RADS category 3 or 4. 18% (58/317) of category 3 and 4 patients underwent some type of invasive procedure (CT-guided biopsy (7), bronchoscopy (6), surgery (43), other (2)). 4% (7/181) of category 3 and 32% (43/136) of category 4 patients were diagnosed with malignancy. Median time from initial screening exam to tissue diagnosis for malignancy was 11 weeks (range 2-154weeks). Majority of patients who underwent an invasive procedure went directly to either wedge resection or lobectomy without prior tissue diagnosis. Complications were seen in 7% (4/58) of patients, all related to surgery and included air leak (3) and chyle leak (1). 2% (8/317) of patients who underwent an invasive procedure yielded benign pathology. 8% (26/317) patients did not have any imaging follow-up, including 6% (20/181) of category 3 and 2% (6/136) of category 4. 51% (93/181) of category 3 and 41% (56/146) of category 4 patients were downgraded to category 2. The average number of CT exams performed prior to downgrading was 1.3.

CONCLUSION

We found our patient population had greater percentage of category 3 and 4 patients than the estimated population prevalence. A

higher percentage of category 3 and 4 patients ultimately had a malignant diagnosis than predicted. A small proportion of patients had procedures performed for benign diagnosis. Complications among all groups were low.

CLINICAL RELEVANCE/APPLICATION

The high percentage of malignancy diagnosed in Lung-RADS category 4 and, to a lesser extent, category 3 patients emphasizes the importance of adhering to the guidelines in the management of these patients.

SSQ05-04 Assessment of the Vancouver Risk Calculator Compared to ACR Lung Rads Applied to National Lung Screening Trial Nodules

Thursday, Nov. 30 11:00AM - 11:10AM Room: S402AB

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PURPOSE

To compare the efficacy of the Vancouver Risk Calculator (VRC) with ACR LungRADs in determining malignancy among solid nodules identified in the National Lung Screening Trial (NLST).

METHOD AND MATERIALS

The study received approval from the IRB and NCI CDAS system to use NLST data. All nodules detected in the CT arm of the NLST were considered for inclusion. After exclusions due to inability to determine malignant vs benign nodule status (no gold standard), incomplete data sheets preventing the use of the risk calculator, and subsolid nodule type, 4078 nodules were available for evaluation. The 4078 solid nodules were scored using the VRC consisting of 9 nodule and patient parameters (output = % likelihood of malignancy, malignancy threshold tested at >5% likelihood) and LungRADS (output = Category 2-4B, malignancy defined as 4A or 4B, malignancy defined as >5% likelihood as noted in LungRADS table on ACR website). Comparison was performed between LungRADS and the VRC to determine their respective sensitivity, specificity and accuracy to distinguish between benign and malignant solid nodules.

RESULTS

For ACR LungRADS category 2 (non-malignant), there were 2,141 nodules of which 3 were malignant. The VRC designated 0 malignant with 0 False Positives (FP) for the 5% threshold. For LungRADS category 3 (non-malignant) there were 1,136 nodules of which 7 were malignant. The VRC designated 3 malignant, with 31 false positives. For LungRADS category 4A (malignant), there were 630 nodules of which 26 were malignant. The VRC designated 25 malignant with 244 FP. For LungRADS category 4B (malignant), there were 171 nodules of which 64 were malignant. VRC designated 64 malignant with 107 FP. Overall sensitivity, specificity and accuracy for LungRADS was 90.0%, 82.1% and 82.3%, respectively and for VRC 5% threshold, it was 92.0%, 90.4% and 90.4%, respectively.

CONCLUSION

In comparison with ACR LungRads, the Vancouver risk model demonstrated higher sensitivity, specificity and accuracy in determining malignancy among solid nodules in the NLST.

CLINICAL RELEVANCE/APPLICATION

For solid nodules, risk models such as the Vancouver risk calculator may provide a superior assessment of the likelihood of malignancy than the ACR LungRads categories.

SSQ05-05 Management of New Solid Nodules at First Follow-Up after Detection in Incidence Screening Rounds of Low-Dose CT Lung Cancer Screening

Thursday, Nov. 30 11:10AM - 11:20AM Room: S402AB

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PURPOSE

Low-dose CT (LDCT) lung cancer screening is recommended by US guidelines for high-risk individuals. New solid nodules detected after baseline screening have a high lung cancer probability and their management is crucial for the success of a screening program. Currently, there is no evidence for the management of nonresolving new solid nodules at first follow-up after detection.

METHOD AND MATERIALS

In this ongoing, multicenter, randomized controlled trial, 15,822 participants were randomly assigned to screening with LDCT (n=7,915) or no screening (n=7,907). In total, 7,557 individuals underwent baseline screening and 7,295 participants underwent subsequent screening rounds. We included all participants with solid non-calcified nodules, registered by the radiologists as new or

<15mm³ (study detection limit, ca. 3mm) at previous screens, that received a follow-up scan after detection. High-risk nodules (>500mm3) which led to immediate referral at first detection were excluded. Nodule volume was generated semiautomatically by software.

RESULTS

Overall, 680 participants with 1,020 low-intermediate risk new solid nodules were included. A total of 562 (55%) new solid nodules were resolving and in 321 (47%) participants all detected new solid nodules were resolving nodules. In 356 (52%) participants a new solid nodule persisted as solid nodule, with 25 (7%) participants being diagnosed with lung cancer in such a nodule. At follow-up, volume doubling time (VDT) (area under the curve [AUC]: 0.913, 95%CI 0.861-0.965), volume (AUC: 0.875, 95%CI 0.822-0.928), and VDT combined with a previously established >=200mm3 volume cutoff (AUC: 0.939, 95%CI 0.904-0.974) had high discriminatory power for lung cancer. The combination of <=590days VDT or >=200mm3 volume at follow-up provided 100% (95%CI 84-100%) sensitivity, 84% (95%CI 80-87%) specificity, and 27% (95%CI 19-37%) positive predictive value for lung cancer.

CONCLUSION

More than half of new solid nodules identified in LDCT lung cancer screening are resolving nodules. At first follow-up, a cutoff combination of <=590days VDT or >=200mm3 volume can be used for risk stratification.

CLINICAL RELEVANCE/APPLICATION

Management of new nodules detected after baseline determines the success of a screening program. Appropriate risk stratification by VDT and volume at follow-up could prevent delayed cancer diagnosis.

SSQ05-06 Use of a Risk Model Combining Clinical Information and CT Findings to Customize Follow-Up Intervals in Lung Cancer Screening

Thursday, Nov. 30 11:20AM - 11:30AM Room: S402AB

Awards
Trainee Research Prize - Fellow

Participants
Anton Schreuder, MD, Nijmegen, Netherlands (*Presenter*) Nothing to Disclose
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PURPOSE

The U.S. has launched an annual CT lung cancer screening program, irrespective of individual participants' malignancy risk. We developed a risk model based on information from the baseline CT and clinical information to calculate the trade-off between cost savings by omitting one year follow-up scans in low risk individuals and the number of delayed cancer diagnoses.

METHOD AND MATERIALS

We used data from the National Lung Screening Trial. We selected all subjects who underwent a baseline scan and a one year follow up scan, those diagnosed with lung cancer after the baseline scan were excluded. Using baseline clinical data and baseline scan variables, various models were developed to estimate the risk of developing lung cancer after the one year follow-up scan, using backward stepwise regression. The full model included both clinical and scan variables. Additionally we tested a clinical-only model and a nodule-only model, the latter including the largest nodule diameter as the only variable. Furthermore, the published Brock and Patz models were validated on the same data set.

RESULTS

174 of 24,542 participants were diagnosed with lung cancer in the year after the first annual follow up. Best predictors included in the full model were older age, higher smoking duration and intensity, shorter smoking quit time, previous COPD and cancer diagnosis, emphysema, longest and perpendicular diameter of the largest nodule, presence of subsolid nodules, presence of an upper lobe nodule, and presence of a spiculated nodule. Using our full model, 9,972, 16,298, 19,726, and 21,158 of the cancer-free persons could have safely avoided the one year follow-up scan, at the expense of delaying the diagnosis of 17, 44, 70, and 88 of the lung cancer patients, respectively. The area under the ROC curve ranged from 0.79 with our full model to 0.73 with the Brock model to 0.67 in the Patz model.

CONCLUSION

Predictive models based on clinical and baseline scan information can be used to personalize follow up intervals in lung cancer screening, saving radiation and costs. Results differed substantially depending on the risk model used.

CLINICAL RELEVANCE/APPLICATION

Our model can be used to improve lung cancer screening efficiency by selecting a substantial proportion of participants for a two year follow-up interval, while delaying lung cancer diagnosis in only very few cases. This can greatly reduce costs, radiation burden and radiologist's work-load.

SSQ05-07 A Novel DeepWise CAD System for Detection of Pulmonary Nodules

Thursday, Nov. 30 11:30AM - 11:40AM Room: S402AB

Participants

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PURPOSE

To validate a novel DeepWise computer-aided detection (CAD) system for automated detection of pulmonary nodules.

METHOD AND MATERIALS

The DeepWise CAD system designed by means of a specialized deep neural network is a novel and more intelligent CAD system to detect pulmonary nodules automatically. A public data set LIDC-IDRI and an in-house data set (a total of about 7,000 nodules) were used as the development data set. One hundred consecutive low-dose CT (LDCT) scans in a screening program and 100 specified and matched nodules in another 60 LDCT scans were independently evaluated by two radiologists (Radiologist *1, 2*) and the DeepWise CAD system to identify nodules larger than or equal to 2 mm in average diameter. All the nodules detected by both the radiologists and the system were reviewed jointly by another two chest radiologists, who were experienced in LDCT lung cancer screening, and a "true" nodule count was determined. The performance of the two radiologists and the DeepWise CAD system were compared.

RESULTS

Radiologist *1, 2* and the DeepWise CAD system detected 193, 115 and 271 nodules, respectively. Of the 325 separate nodules detected by the three techniques, 282 were classified as true nodules on consensus review. Of the true nodules present, the detection date of the Radiologist 1, 2 and the DeepWise CAD system were 66.3% (187/282), 40.8% (115/282) and 83.0% (234/282), respectively. And the 48 nodules missed by the DeepWise CAD included 41 solid nodules with an average diameter of less than 5 mm and 7 ground glass nodules. 187 (96.9%) of 193 Radiologist 1-detected nodules were true nodules, all 115 Radiologist 2-detected nodules were true nodules, and 234 (86.3%) of 271 of the DeepWise CAD-detected nodules were true nodules. The DeepWise CAD system identified 37 lesions that on consensus review were false-positive nodules, a rate of 0.23 (37/160) per patient.

CONCLUSION

The novel DeepWise CAD system detected 83.0% of true nodules, which was significantly superior to radiologists. And its false positive rate, 0.23 per patient, was significantly cut down.

CLINICAL RELEVANCE/APPLICATION

With the popularity of MDCT, the detection rate of lung nodules was significantly improved, which brought great pressure to radiologists. And the false positive nodules detected by traditional CAD software were so much that the clinical application was limited. So we need a more intelligent CAD system to detect pulmonary nodules accurately.

SSQ05-08 Lung-RADS Performs Well in a Diverse and Underserved Lung Cancer Screening Population

Thursday, Nov. 30 11:40AM - 11:50AM Room: S402AB

Awards
Student Travel Stipend Award

Participants
Hannah Milch, MD, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the performance of Lung-RADS in a clinical setting that markedly differs from the Lung-RADS score derivation populations.

METHOD AND MATERIALS

Our low dose CT (LDCT) lung cancer screening program is referral based and relies on a bilingual coordinator. LDCTs were interpreted by subspecialized chest radiologists using Lung-RADS. 30% (356/1181) were interpreted prior to Lung-RADS release and assigned an internally derived 1-5 score that was later converted to Lung-RADS as follows: scores of 1 and 2 to Lung-RADS 1 and 2, scores 3 and 4 to Lung-RADS 3, scores 5a and 5b to Lung-RADS 4a and 4b. Data were obtained by patient interview and electronic medical records.

RESULTS

1181 patients were screened from December 2012- December 2016, median age was 63 [IQR 59-67], 49% (569) men, 75% non-white (31% black, 31% Hispanic, 13% other), 55% (651) Medicaid/Medicare insured, 71% current smokers (median pack-years 45), median socioeconomic status -2.26. Comorbidities: 69% overweight/obese (32%/37%), 68% hypertension, 67% chronic lung disease, 35% diabetes, 17% heart disease, 2.1% HIV positive. Lung-RADS performance: 87% (1030/1181) of baseline LDCTs were negative (Lung-RADS 1 or 2)- lung cancer rate 0.2%(2/1030); 10% (119) Lung-RADS 3- cancer rate 3.4%(4/119); 1.2% (14) Lung-RADS 4a- cancer rate 43% (6/14); 1.5% (18) Lung-RADS 4b- cancer rate 83% (15/18). The overall positive rate (Lung-RADS 3, 4a, and 4b) was 12.8% (151/1181), false positive rate 10.9%, and positive predictive value (PPV) 16.6% (CI 14.0-19.5). Sensitivity was 92.6%. Mortality in lung cancer patients was 27% vs 0.6% in non-lung cancer patients.

CONCLUSION

Although Lung-RADS was derived and retrospectively validated primarily via the NLST and I-ELCAP screening cohorts, it performs well clinically in a predominantly poor, ethnically diverse population, meeting or exceeding benchmarks.

CLINICAL RELEVANCE/APPLICATION

In clinical practice Lung-RADS increased the PPV of the LDCT exam to 16.6% versus 3.8% in the NLST and significantly exceeded ACR cancer diagnosis benchmarks for Lung-RADS 4a-43% and 4b-83% (benchmarks: 4a- 10-15%, 4b- >15%). .

SSQ05-09 Access to Lung Cancer Screening Services: Preliminary Analysis of Geographic Service Distribution Using the ACR Lung Cancer Screening Registry

Thursday, Nov. 30 11:50AM - 12:00PM Room: S402AB

Awards
Student Travel Stipend Award

Participants
Paniz Charkhchi, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose
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PURPOSE

Lung cancer has the highest mortality rate among all types of cancer in the United States. NLST demonstrated low dose CT (LDCT) for lung cancer screening decreases both lung cancer related mortality and all-cause mortality. Currently, the only CMS approved lung cancer screening registry is the Lung Cancer Screening Registry (LCSR) administered by the American College of Radiology (ACR). We aim to show the availability of facilities, participated in the LCSR, in the each state to provide lung cancer screening services to those who are screen-eligible and to assess if facility availability is proportionate to state-level demographic and lung cancer related outcome.

METHOD AND MATERIALS

The ACR LCSR list of participating lung cancer screening facilities was used as a proxy for the availability of lung cancer screening facilities in each state. Additionally, we normalized the number of facilities by state by the number of screening-eligible individuals using BRFSS data. State-level demographics were obtained from the 2015 BRFSS: poverty level, insured population, unemployed, Black and Latino. We obtained data on lung cancer incidence and death, number of active physician per 100,000 and Medicare expenditure. We performed linear regression models to examine the influence of the covariates on state-level screening facility number by state using Stata 11.

RESULTS

As of 11/18/2016, 2,423 facilities participated in the LCSR, with a median number of 32 facilities per state (interquartile range 63) with highest number in the Florida (n=198) and the lowest number in the District of Colombia and Montana (n=3). Figure 1 graphically represents the location and distribution of lung cancer screening facilities by proportion of screen-eligible individuals. There was a positive independent effect (OR=12.90, 95% CI =11.01- 14.79) between state-level number of screening facility and rate of screen-eligible individuals rate per 100,000. There were no significant correlations between numbers of facility and lung cancer outcomes, state demographic characteristics, or physician supply and Medicare expenditure.

CONCLUSION

Although there was a positive relation between facility number and screening eligible rate, there is a further need to evaluate the geographic access of these facilities.

CLINICAL RELEVANCE/APPLICATION

Screen eligible by state remains additional work define if other access barriers exist.

SSQ06

Science Session with Keynote: Emergency Radiology (Torso Trauma)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S405AB

CT ER GI VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Jamlik-Omari Johnson, MD, Atlanta, GA (*Moderator*) Research Grant, Koninklijke Philips NV; Royalties, Cambridge University Press
Savvas Nicolaou, MD, Vancouver, BC (*Moderator*) Institutional research agreement, Siemens AG

Sub-Events

SSQ06-01 Emergency Radiology Keynote Speaker: Role of Split Bolus Contrast Infusion for Trauma CT

Thursday, Nov. 30 10:30AM - 10:40AM Room: S405AB

Participants
Johann B. Dormagen, MD, Oslo, Norway (*Presenter*) Nothing to Disclose

SSQ06-02 Impact of Whole-Body CT in Non-Severely Injured Patients: Role of Split Bolus versus Delayed Arterial Phase as a Diagnostic Tool in Potential Medicolegal Controversies

Thursday, Nov. 30 10:40AM - 10:50AM Room: S405AB

Participants
Alessandro A. Lemos, MD, Milan, Italy (*Presenter*) Nothing to Disclose
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PURPOSE

Whole body CT in non-severly injured patients is frequently a cause of dispute between referring trauma phisicyans and vetting radiologists. On the other hand, missing a potentially treatable injury is equally unacceptable and may lead to lawsuits. This study aims to determine whether the use of split bolus versus delayed arterial phase might be of value in the assessment of non-severely injured trauma patients.

METHOD AND MATERIALS

A retrospective sample of 72 polytrauma whole-body CT scans, performed from January 2015 to March 2017 at a major trauma centre was analysed. All patients with an ISS less than or equal to 16, represented our inclusion criteria. One pass poly trauma CT scans were performed by a delayed arterial phase acquisition (bolus-triggering technique starting after 20sec. from peak enhancement) or by the split bolus technique (1th bolus with 65ml of contrast at 2mL/s, following by 10sec. delay, 2th bolus with 85mL of contrast at 3.5 mL/s following by a flush of 40ml of saline at 3.5 mL/sec, initiate scan at 77 sec.). Differences in attenuation values of the liver, spleen, pancreas and kidneys between the two acquisition protocols were expressed in Hounsfield Units. Statistical comparison between the two groups was determined by using the Chi-square test.

RESULTS

Forty patients were scanned using the split bolus protocol, whereas the remaing 32 patients received the delayed arterial phase protocol. Overall, 10 patients had bone fractures, 3 had pneumothoraces , 3 had renal contusions, 1 had renal, adrenal, and hepatic contusions and 3 had vascular injuries. There was no significant statistical difference in regard to overall attenuation values of the liver in both groups: (117 vs 123 HU, p=0.18) and pancreas (112 vs 131 HU, p=0.46), whereas differences were statistically significant in regard to the spleen (143 vs 119 HU , p=0.04), and kidneys (205 vs 225 HU, p=0.03).

CONCLUSION

Our results show that split bolus acquisition technique is associated with more homogeneous contrast enhancement of the spleen and kidneys and can be implemented as a standard acquisition protocol in non-severely injured patients.

CLINICAL RELEVANCE/APPLICATION

The integration of a low radiation dose technique such as split bolus in daily clinical practice in patients in whom the indications for standard whole-body CT are 'borderline', can reduce disputes between referring trauma physicians and vetting radiologists and avoid lawsuits.

SSQ06-03 Imaging of Delayed Manifestations of Abdominopelvic Trauma

Thursday, Nov. 30 10:50AM - 11:00AM Room: S405AB

Participants
Mohammed F. Mohammed, MBBS, Vancouver, BC (*Abstract Co-Author*) Speaker, Siemens AG; Employee, X-Ray Teleradiology Services
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David Mak, BSC, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
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Faisal Khosa, FFR(RCSI), FRCPC, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Abdominal injuries presenting to hospital emergency departments often warrant an initial modality of imaging to screen for injuries from the initial traumatic incident.A handful of traumatic injuries may not be identified or fail to manifest on the initial CT, resulting in delayed manifestations of abdominal trauma. This may lead to subsequent readmission, delayed management, and possibly severe complications.No studies have investigated this topic in a holistic, whole-body approach. As such, our study aims to quantify the frequency and type of delayed abdominal injuries, and to determine the etiology behind the delayed manifestation and diagnosis.

METHOD AND MATERIALS

For this IRB-approved retrospective study, the hospital trauma registry was queried for patients with multi-trauma and ISS >= 16 between January 2010 and August 2016 and had initial Abdominopelvic CT on admission, yielding 3735 studies. Patients who received a follow-up abdominopelvic CT within 6 months from the initial scan were included in our study (203). The clinical indication and radiological findings were reviewed, clinical indications for repeating CT study, presence or absence of a new radiological finding, organ-related abnormality and clinical management accordingly.

RESULTS

203 patients (5.44%) received follow up CTs. The average elapsed time between the initial and follow-up CT was 15±27 days. Individual clinical indications (n=243) included evaluation for abdominal collection (n=97), 39.92%; solid organ injury (n=85), 34.98%; Bowel-Related abnormalities (n=31), 12.76% and miscellaneous indications (n=30), 12.35%. Delayed manifestations and complications of trauma were found in 41 cases (20.1 %) and were attributed to 46 abnormalities related to new abdominal collections and hematoma (n=17) ; solid organ injury (n=19); bowel and mesentery (n=6); diaphragmatic injury (n=3) and urinary bladder injury(n=1). Based on the radiological findings on follow up CT studies, 8 Surgical and 16 interventional procedures were performed.

CONCLUSION

A small percentage of traumatic injuries may not be identified on the initial CT, resulting in delayed traumatic manifestations, leading to an increase in morbidity.

CLINICAL RELEVANCE/APPLICATION

Understanding the frequency and pattern of delayed abdominal injuries increases the awareness of radiologists to injuries that require scrutiny on initial trauma imaging and closer follow up.

SSQ06-04 A 2017 National Survey to Assess Blunt Trauma CT Protocols at U.S. and Canadian Trauma Centers

Thursday, Nov. 30 11:00AM - 11:10AM Room: S405AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To our knowledge, there are no published societal or national guidelines for blunt trauma CT imaging protocols, including on the use of whole-body CT (WBCT). Our goal was to survey trauma radiologists in the United States and Canada in order to determine if there is any consensus on indications for WBCT, the algorithms used in blunt trauma patients, and the most common protocols used.

METHOD AND MATERIALS

With IRB approval, an anonymous 17 question survey was distributed via email link to 78 radiology departments at 78 trauma centers in the U.S. and Canada. The study was open for a two-week period in March 2017. A commercially available website that allows subscribers to create and analyze surveys was used for analysis.

RESULTS

31 respondents from 31 institutions completed the survey (response rate 40%). 52% use WBCT protocol for blunt abdominal trauma. For those that use WBCT, half report that a single radiologist interprets the entire scan. The most common blunt trauma chest CT protocol is single phase, contrast-enhanced arterial phase imaging (72%). The most common blunt trauma abdomen/pelvis CT protocol is a single IV contrast injection followed by portal venous phase imaging (48%). 76% reported not routinely obtaining delayed phase abdominal and pelvic images. Spine reconstructed images are always created at 52% of institutions. When asked if trauma CT images are routinely reviewed by a radiologist before the patient is moved from the CT table, the two most common answers were "no" (55%) and "yes, a majority are reviewed by a radiology resident" (28%). 86% of institutions routinely use filtered-back projection or iterative reconstruction with trauma CTs. When asked who interprets trauma CTs performed during what would be considered after hours, the most common answer was "after-hours interpretations are provided by an in-house or remotely situated attending radiologist who is a full-time staff physician at the institution" (72%). 50% of institutions do not routinely assess renal function prior to blunt trauma CT imaging.

CONCLUSION

There is substantial variation across U.S. and Canadian-based institutions regarding the current use of whole-body CT in blunt trauma, how trauma CT scans are protocoled, and who interprets them.

CLINICAL RELEVANCE/APPLICATION

There is a lack of uniformity in how patients with blunt trauma are currently scanned with CT across U.S. and Canadian trauma centers.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Douglas S. Katz, MD - 2013 Honored EducatorDouglas S. Katz, MD - 2015 Honored Educator

SSQ06-05 Traumatic Vascular Injuries of Abdominal Solid Organs: Is Split-Bolus Really That Bad?

Thursday, Nov. 30 11:10AM - 11:20AM Room: S405AB

Participants
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PURPOSE

To evaluate the accuracy of the single-pass split-bolus whole body CT protocol compared to the conventional segmented multi-pass protocol for traumatic vascular injuries of solid abdominal organs.

METHOD AND MATERIALS

745 trauma patients were retrospectively included; 350 patients in the conventional segmented multi-pass whole body CT group and 395 patients in the split-bolus single-pass whole body CT group. Radiology reports were analyzed for presence of contrast extravasation, hemorrhage and vascular injuries. Electronic patient records were analyzed for subsequent hemorrhagic events during follow-up either in clinical records or follow-up imaging radiology. Mortality analysis was performed on patients who died since their presentation in the hospital.

RESULTS

In total, 79 patients suffered hemorrhages of which 35(10%) in the conventional group and 44(11.1%) in the split-bolus group. There were no missed hemorrhages found in either group. There was no statistically significant difference of the incidence of vascular injuries between groups. No cases of mortality were found to be related to missed vascular injuries.

CONCLUSION

Using the split-bolus single-pass whole body CT protocol for the initial evaluation of trauma patients does not lead to clinically significant missed vascular injuries of abdominal solid organs.

CLINICAL RELEVANCE/APPLICATION

Our work suggests that the split-bolus protocol does not underperform compared to the conventional protocol and should be considered as a method of radiation dose reduction in the trauma population.

SSQ06-06 Emergency Department Imaging Super-users: Utilization Characteristics of the Most Resource Intense Patients

Thursday, Nov. 30 11:20AM - 11:30AM Room: S405AB

Participants
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PURPOSE

To identify and characterize the most frequent users of emergency department (ED) imaging ("Super-users").

METHOD AND MATERIALS

All patients with at least 1 ED visit in 2016 within a four-hospital healthcare system were retrospectively identified. Characteristics of those encounters and all associated radiology examinations were then analyzed.

RESULTS

Overall, 126,940 unique patients presented for 187,603 separate ED visits which resulted in a total of 192,142 imaging examinations. Mean annual ED visits per patient were 1.48 ± 1.66 (range: 1-294). The top 0.32% (n=408) of patients visited the ED >10 times in the year and accounted for 3.8% of all ED visits; the top 1.7% (n=2,158) of patients visited the ED >5 in the year and accounted for 10.48% (n=19,667) of all ED visits. 73,672 ED patients (58%) underwent at least 1 ED imaging examination, with a mean of 2.6 exams per patient (SD 2.69; range: 1-60). 2,124 patients (1.67% of the total ED patients) underwent >=10 imaging examinations, and accounted for 15.01% of the total annual ED imaging volume. ED imaging volume consisted of CT (n=68,370; 35.6% of imaging volume; range per patient 0-21), radiography (n=67,409; 35.1%; range 0-39), ultrasound (n=29,985; 15.6%; range 0-27), MRI (n=15,433; 8.03%; range 0-13), with far fewer numbers of all other modalities.

CONCLUSION

A tiny fraction (1.67%) of all ED patients account for a disproportionately large percentage (15%) of all ED imaging volume. Further study of these Super-users may catalyze targeted interventions to control unnecessary ED imaging volume growth, contain costs, and decrease per-patient radiation exposure.

CLINICAL RELEVANCE/APPLICATION

Further characterization of this vulnerable patient population may facilitate informed targeted interventions to optimize ED imaging, restrain costs, and decrease per-patient radiation exposure.

SSQ06-07 Have We Gone Too Far? Active Arterial Bleeding: Not as Bad as We Thought

Thursday, Nov. 30 11:30AM - 11:40AM Room: S405AB

Participants
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PURPOSE

The presence of active bleeding in computed tomography (CT) is usually related to failure of conservative treatment in the context of a traumatic hemorrhage. Our goal is to evaluate if all patients with a traumatic active arterial extravasation should be managed aggressively or not, and if there is any predictor factor in the therapeutic decision-making.

METHOD AND MATERIALS

We performed a retrospective analysis of CT angiographies with active arterial extravasation ("blush") in adult trauma patients admitted from January 2013 to March 2017 at the emergency department. Patients with intestinal, aortic or spontaneous bleeding were excluded. All studies were review in a posterior second lecture. We reviewed the management performed and analyzed several clinical, laboratory, and radiological parameters before the treatment. We made a descriptive, univariant and multivariate study with the software SPSS Statistics v.20.

RESULTS

Out of 152 patients included in the study, 41 were remove in the review and the analysis was performed on a final population of 111 patients. We followed two different groups: patients who required surgical or radiologic intervention (75), and the remaining patients who were managed conservatively (36), both with a good outcome. Between the conservative and aggressive management groups, we found statistically significant differences in hemodynamic stability (83% vs. 42%; $p < 0.001$), lactate level (mean 2 vs.4.2 mmol / L; $p < 0.001$), arterial blush measurement (mean 12 vs.19 mm; $p = 0.05$) and localization (55% vs. 36% with peripheral location; $p = 0.03$). The area under the ROC curve for lactate level and arterial blush size like predictor factors was 0.7 in both cases. The combination of statistically significant variables had a sensitivity of 80%, a specificity of 64%, a positive predictive value of 86% and a negative predictive value of 52% to predict the need of agressive management.

CONCLUSION

Some patients with traumatic active arterial extravasation in a CT angiography can be managed conservatively based on clinical, laboratory and radiological data. We consider that lactate level and arterial blush size are good predictor factors. An exhaustive investigation that define solid criteria for therapeutic decision-making is necessary.

CLINICAL RELEVANCE/APPLICATION

Several of the traumatic active arterial extravsation detected in emergency CT angiography can be treated conservatively, without any intervention.

SSQ06-08 Unidentified Bright Objects of Spleen on Arterial Phase CT: Differentiating features of this Mimicker of

Splenic Vascular Injury in Blunt Abdominal Trauma

Thursday, Nov. 30 11:40AM - 11:50AM Room: S405AB

Participants
Naren Hemachandran, MBBS, New Delhi, India (*Presenter*) Nothing to Disclose
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PURPOSE

We describe Unidentified Bright Objects of Spleen (UBOS) as hyperdense areas around splenic lacerations on arterial phase (AP) CT which are isodense on portal venous phase and have no abnormal correlate on digital subtraction angiography (DSA). They need to be differentiated from splenic vascular injuries like active contrast extravasation (AE) and pseudoaneurysms (PA) as it has management implications. We describe a few signs and their diagnostic accuracy to differentiate PA/AE from UBOS

METHOD AND MATERIALS

Retrospective analysis of patients of blunt abdominal trauma who had undergone dual phase CT & DSA was done. All hyperdense lesions on AP were evaluated for their margins (well defined/ill-defined), presence of the lesion on adjacent/parallel walls of the laceration (wall sign), presence of normal parenchyma in relation to at least one side of the lesion (adjacent parenchyma sign) and string of beads appearance. The difference between the mean CT Hounsfield unit (HU) of the lesion and aorta was also noted in the AP. The diagnostic accuracy of these signs for distinguishing from UBOS was calculated with DSA as gold standard.

RESULTS

In the 43 patients included, 54 hyperdense lesions were detected on AP, which included 22 vascular injuries (11 PA, 11 AE) and 32 UBOS based on DSA. The presence of ill-defined margins had a low sensitivity and specificity (37%, 18% respectively). The adjacent parenchyma sign had a sensitivity of 84% and specificity of 77%. The wall sign and a beaded appearance had a sensitivity of 50% and 65% and a high specificity of 95% and 86% respectively. ROC curve analysis done for the difference in HU between the aorta and the lesion showed that a difference of over 50 HU had a sensitivity of 88.9% and specificity of 90.6% (AUC - 0.896).

CONCLUSION

A difference of over 50 HU between the lesion and aorta & the adjacent parenchyma sign had highest diagnostic accuracy while the wall sign and beaded appearance had a high specificity but a low sensitivity for identifying UBOS

CLINICAL RELEVANCE/APPLICATION

Accurate differentiation of unidentified bright objects of spleen from splenic vascular injuries has management implications and is possible with the above described signs

SSQ06-09 Radiology in the Midst of the Opioid Epidemic: 12-year Analysis of Imaging Findings, Mortality and Opioid Prescription History among Patients with Intravenous Substance Use Disorders (IV-SUDs) Presenting to Emergency Radiology

Thursday, Nov. 30 11:50AM - 12:00PM Room: S405AB

Participants
Renata R. Almeida, Boston, MA (*Presenter*) Nothing to Disclose
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Ajay K. Singh, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To assess the prevalence and type of IV-SUDs imaging complications, mortality rate, and history of opioid prescriptions (OP) and in patients presenting to Emergency Radiology (ER).

METHOD AND MATERIALS

HIPAA compliant-IRB approved retrospective study of 1031 patients who presented to ER (2005 to 2016) to assess IV-SUDs complications. Demographics, clinical symptoms, imaging diagnosis, history of OP, and dates of death were recorded. Exams were categorized by imaging diagnosis, modality and specialty. Analyses for significant differences were done.

RESULTS

In 1031 patients (65% men; mean age 36 yrs; 78% white; 95% English speakers), 1673 exams (779 X-rays, 544 CT, 292 MRI and 58 US) were performed (1-13 exams per patient, mean 1), accounting for 0.2% (1673/854299) of all ER studies in the same period. 52% of patients had 1 or more studies with IV-SUDs complications. The rates of positive imaging per imaging specialty were: GI 77% (113/146), MSK 52% (419/802), Vascular 48% (77/162), Neuro 47% (97/206), and chest 25% (90/356). Most frequent clinical symptoms were local complications of injections (27%, 450/1673), respiratory (15%, 251/1673) and back pain (13.4%, 224/1673). History of OP before the first imaging was present in 30% (310/1031) of cases (mean 10 prescriptions per patient); significantly more often in women (37%, 128/348), than men (27%, 182/673, p=0.008). Mean time from OP to first imaging was 51 months (SD

39); significantly shorter in men (45 months) than women (51 months, p=0.01). Overall death was recorded in 11.7% (121/1031) of patients; significantly higher in patients with positive imaging diagnosis of IV-SUDs complications (14%, 73/534) than in those without (10%, 48/449, p=0.04). 5-yr mortality rates were: 7% (73/1031) overall; higher in patients with prior opioid prescription (9%, 29/310) than in those without (6%, 44/721, p=0.06); higher in patient with imaging complications (6%, 33/534) than in those without (4%, 21/427, p=0.2).

CONCLUSION

There is a high prevalence of multisystem IV-SUDs imaging complications among patients presenting to the ER. Patients with positive imaging findings and prior OP have a higher overall mortality rate compared to patients with negative imaging.

CLINICAL RELEVANCE/APPLICATION

Understanding factors associated with IV-SUDS imaging complications is fundamental to designing responsive patient care models that can better support the health and survival of this vulnerable population.

SSQ07

Gastrointestinal (Multimodality)

Thursday, Nov. 30 10:30AM - 12:00PM Room: E350

CT GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Olga R. Brook, MD, Boston, MA (*Moderator*) Nothing to Disclose
Janio Szklaruk, MD, PhD, Houston, TX (*Moderator*) Nothing to Disclose
Aoife Kilcoyne, MBBCh, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSQ07-01 Trauma Related Pseudopneumoperitoneum-Costochondral Vacuum Phenomenon

Thursday, Nov. 30 10:30AM - 10:40AM Room: E350

Participants
Gregory P. Tarr, MBChB, PhD, Auckland, New Zealand (*Presenter*) Nothing to Disclose
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PURPOSE

To determine the typical anatomical distribution of anterior ectopic gas resembling pneumoperitoneum and to determine the relationship of this finding with trauma and clinical outcomes using archival CT.

METHOD AND MATERIALS

In total, 492 consecutive trauma patients between two separate geographical centres were included to be screened. One hundred and eighty-six patients with recognised causes for ectopic gas were excluded, leaving 306 patients (211 male, mean age 44.5) for analysis by dual consensus between the two centres. A further 200 non-trauma CT scans were consecutively selected as a control group.

RESULTS

The pseudopneumoperitoneum was related to trauma (p=0.0001) and identified in 5.2% of patients after exclusions. Pseudopneumoperitoneum occurred bilaterally and consistently found to be adjacent to the lower 6 anterior ribs near the costochondral junction. Pseudopneumoperitoneum was independently associated with high velocity trauma. There were no significant differences between sides, gender or injury severity score. None of the patients with pseudopneumoperitoneum had evidence for hollow viscus perforation at laparotomy or clinical examination.

CONCLUSION

Pseudopneumoperitoneum is a post traumatic phenomenon centred near the costochondral junction of the lower 6 anterior ribs. These findings have potentially significant clinical implications and are therefore important to recognise in order to prevent unnecessary laparotomy in the trauma setting.

SSQ07-02 Misty Mesentery Is Not Associated With Baseline or New Diagnosis of Cancer: A Matched Cohort Study

Thursday, Nov. 30 10:40AM - 10:50AM Room: E350

Awards
Student Travel Stipend Award

Participants
Sivan G. Marcus, BS, San Francisco, CA (*Presenter*) Nothing to Disclose
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PURPOSE

To compare the prevalence of a known diagnosis of cancer in patients with and without misty mesentery (MM) at baseline imaging, and to determine its association with the development of a new diagnosis of cancer.

METHOD AND MATERIALS

This was a retrospective, HIPAA compliant, IRB approved study of patients with and without MM on CT scans acquired from January 1, 2000 to December 31, 2010. We searched our RIS database for reports that included keywords associated with MM. All scans were reviewed to confirm the presence of MM. 4:1 age- and gender-matched controls without MM were identified. Medical records were reviewed and the following data noted: date of CT, use of iodinated IV contrast, CT protocol (noncon, single, or multiphase), baseline nonmalignant diagnoses, history of abdominal malignancy known at the time or identified on the CT scan, subsequent diagnosis of cancer, and date of the new diagnosis or last encounter. Data was analysed with Pearson's chi-square test, two-sample Student's t-test, and Cox proportional hazard models (only patients who did not yet have a baseline diagnosis of cancer). We used STATA® for statistical analysis. An a of 0.05 was considered statistical significance.

RESULTS

Our sample consisted of 148 patients with MM (60 women, 40.54%) and 600 patients without it (236 women, 39.3%) . The mean age of patients were 63.5 years and 61.9 years for patients with and without MM, respectively. No statistically significant difference in any non-malignant diagnoses. Patients with MM were less likely to have a malignancy at baseline (RR = 0.764, absolute difference 12.3% p=0.008). Patients with MM had a longer mean follow-up duration than controls (1742 days, standard deviation = 1545.0 versus 1391 days, standard deviation = 1467.4; P = 0.01). On survival analysis, we observed an increased risk of developing any cancer in MM patients, but this effect was not statistically significant (HR = 1.71, 95% CI 0.93-3.15, p=0.083)

CONCLUSION

We found no clear evidence that patients with MM are more likely to have cancer at the time of baseline imaging or to be later diagnosed with cancers previously thought to be associated with misty mesentery, such as lymphoma.

CLINICAL RELEVANCE/APPLICATION

Further testing is not necessary following the diagnosis of MM, and perhaps its identification on cross-sectional reports should be ommitted or at least not emphasized to minimize patient and provider anxiety.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Antonio C. Westphalen, MD - 2017 Honored EducatorSpencer C. Behr, MD - 2017 Honored Educator

SSQ07-03 Can Quantitative and Semi-quantitative Computed Tomography Analysis Predict Outcomes of Complex Ventral Hernia Repair?

Thursday, Nov. 30 10:50AM - 11:00AM Room: E350

Awards
Student Travel Stipend Award

Participants
Sara Pourhassan Shamchi, MD , Philadelphia, PA (*Presenter*) Nothing to Disclose
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PURPOSE

Component separation is a commonly used technique allowing for sufficient fascial approximation during complex ventral hernia repair (VHR). However, in certain cases, despite component separation, fascial apposition is not possible resulting in bridged VHR. Prior studies have suggested a role for computed tomography (CT) in preoperative planning for VHR. We hypothesized that CT characteristics of abdominal wall musculature may correlate with the defect size and outcomes of fascial approximation during surgery.

METHOD AND MATERIALS

Consecutive patients who underwent complex VHR using component separation technique and available operative note and pre-operative abdominal CT scans were retrospectively recruited in this IRB-approved study. Specific parameters such as defect size, abdominal wall fat thickness; thickness and mean attenuation of abdominal wall muscles including rectus abdominis (RA), external oblique (EO) and internal oblique (IO) were measured in multiple levels on axial planes using Osirix software (Pixmeo, Bemex, Switzerland) and used for further analysis.

RESULTS

Forty patients meeting inclusion criteria were included. Twenty patients had successful fascial approximation (unbridged group) while in the other 20 patients fascial bridging was used for hernia repair (bridged group). The defect width had a positive correlation with mean EO thickness (Correlation Coefficient (CC)= 0.43, p=0.006), IO thickness (CC=32, p=0.43), abdominal wall fat thickness (CC=0.35, p=0.03) and EO/IO mean attenuation ratio (CC=0.45, p=0.004). Mean defect width on axial plane (15.0±5.2 vs. 9.3±3.7 cm, p<0.001) and EO/IO mean attenuation ratio (1.17±1.9 vs. 0.24±1.12, p=0.02) were significantly higher for patients who

required bridging technique for fascial closure. However, abdominal wall fat thickness did not significantly differ between groups.

CONCLUSION

Characterization of abdominal wall musculature thickness and fat composition by computed tomography might predict the success of fascial approximation in patients undergoing complex VHRs.

CLINICAL RELEVANCE/APPLICATION

Upon validation in larger prospective studies, these findings might enable preoperative planning and intervening to improve the outcomes in this patient population.

SSQ07-04 Role of High Resolution Transperineal Sonography and Its Comparison with MRI in Peri-Anal Fistulous Disease

Thursday, Nov. 30 11:00AM - 11:10AM Room: E350

Participants
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PURPOSE

To describe the high resolution transperineal sonographic findings in perianal fistulous diseases and to compare its efficacy with MRI, considering surgical results as gold standard.

METHOD AND MATERIALS

This prospective study included 180 patients with clinical suspicion of perianal fistulous disease. These patients were subjected to 2-D high resolution transperineal sonography which was performed in lithotomy position using 8MHz linear array transducer, after which they underwent MRI of the perineum on 1.5T Magnet. The results of sonography and MRI were interpreted by two separate radiologists. The preoperative sonographic and MRI findings were compared with the findings of surgical exploration taken as reference standard and the sensitivity, specificity, positive predictive value and negative predictive values of sonography and MRI were calculated and compared.

RESULTS

Transperineal sonography showed a high sensitivity of 91.5%, specificity of 72% and positive predictive value of 92.7% in detection of primary tract. MRI had comparable sensitivity of 93.2% and specificity of 81%, with positive predictive value of 95.6%. MRI showed a higher diagnostic accuracy in detection of secondary tracts, supralevator extension, whist sonography and MRI had comparable results in detecting intersphincteric collection, crypto glandular abscesses and internal opening. In multiple fistulae, post operative recurrence and associated abscesses both sonography and MRI showed comparable diagnostic efficacy.

CONCLUSION

Transperineal sonography is a highly effective tool in pre-operative assessment and classification of perianal fistulous disease. It has a high sensitivity in detection of primary tract and can accurately identify the secondary tracts, abscesses and internal opening. It is also useful in assessing recurrence in post operative cases.

CLINICAL RELEVANCE/APPLICATION

Transperineal sonography, being a relatively cheap and time saving procedure, can be established as a highly useful alternative to MRI perineum, in view of comparable diagnostic accuracy in cases with perinanal fistulous disease.

SSQ07-05 An MR-Derived Standardized Visceral Adipose Tissue Index (VATI) for Prediction of Insulin Sensitivity

Thursday, Nov. 30 11:10AM - 11:20AM Room: E350

Participants
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PURPOSE

Quantification of visceral adipose tissue (VAT) by MRI is currently performed in many cross-sectional, interventional and epidemiological studies and has shown to be of stronger metabolic relevance compared to other adipose tissue compartments in the human body. However, considering the absolute volume of VAT bears inaccuracies as this has to be interpreted different for subjects with different size. Thus, a VAT-index is introduced - comparable to body mass index, BMI - correcting the VAT-volume by

the square of body height.

METHOD AND MATERIALS

VAT volume was assessed between femoral heads and thoracic diaphragm by axial T1-weighted MRI on a 1.5T whole-body imager (Magnetom Sonata, Siemens Healthcare, Germany). Automatic segmentation of VAT and subcutaneous adipose tissue (SCAT) was performed by a fuzzy-clustering algorithm. In total 952 subjects (603f/349m, mean age 44.6 years) at increased risk for metabolic diseases were included in this prospective analysis. Anthropometrics and insulin sensitivity (IS, by oral glucose clamp) were determined immediately after the MR-session. VAT index (VATI) was calculated by dividing VAT volume (given in l) by the squared body height (cm^2).

RESULTS

VAT volume was in a range between 0.25l and 13.9l and the mean value was twice as much for males (5.6l) compared to females (2.8l). Mean BMI was comparable for males (30.6kg/m^2) and females (29.9kg/m^2). VATI was calculated to 1.76l/m^2 for males and 1.02l/m^2 for females and IS was in a broad range. By applying a stepwise multivariate linear regression analyses (IS as dependent variable) to adjust the effects of covariates (including age, BMI, WHR) and to identify independent relationships, VATI remained as the only significant predictive parameter for IS.

CONCLUSION

MRI has been established as a reliable tool for non-invasive phenotyping. In order to correctly interpret the amount of VAT in the framework of metabolic imaging, the absolute volume should be corrected for body height. It has to be mentioned that these results do not reflect the general population and cut-off values for VATI regarding differentiation of insulin sensitive and insulin resistant subjects remain to be determined.

CLINICAL RELEVANCE/APPLICATION

For a correct interpretation of visceral adipose tissue volume assessed by abdominal MRI, standardization and correction for body height - comparable to body mass index - is advisable.

SSQ07-06 Effect of Hepatobiliary MR Contrast Agent Administration on the Signal Intensity of Peritoneal and Pleural Fluid Effusions

Thursday, Nov. 30 11:20AM - 11:30AM Room: E350

Participants
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PURPOSE

To describe the effect of hepatobiliary-specific MR imaging contrast agent (HBCA) administration on the signal intensity of peritoneal and pleural fluid effusions on T1-weighted MR images.

METHOD AND MATERIALS

From October 2015 to May 2016 all consecutive patients with peritoneal or pleural effusions who underwent HBCA-MRI (Gd-BOPTA or Gd-EOB-DTPA) at 1.5T and 3T were retrospectively included from two centers. The signal intensity of peritoneal and pleural fluids was classified as hypo/iso/hyperintense compared to the splenic parenchyma, before and after HBCA administration. The relative signal enhancement (RE) and the signal-to-noise ratio (SNR) were calculated on pre and contrast-enhanced sequences.

RESULTS

139 patients with peritoneal/pleural effusions without biliary or vascular leakage (mean 60±10-yo, 96 males, 69%) were included. MR imaging was performed for chronic liver disease (n=105), cancer staging (n=21), and other causes (n=15). On T1-weighted hepatobiliary phase (HBP) MR images, the peritoneal fluid appeared hyper/isointense in 88-100%, and pleural effusions in 100% of the patients following Gd-BOPTA administration. On T1-weighted HBP images, all effusions remained hypointense following Gd-EOB-DTPA. The signal intensity of fluids increased with both types of HBCA but RE was significantly higher following Gd-BOPTA than Gd-EOB-DTPA ($p=0.002$ and <0.001 for peritoneal and pleural fluids, respectively), whatever the field strength. RE was significantly correlated with the HBP acquisition time ($r=0.42$, $p<0.001$ and $r=0.50$, $p = 0.033$ for peritoneal and pleural fluids, respectively). It was significantly higher in patients with chronic liver disease following Gd-BOPTA administration ($p=0.009$).

CONCLUSION

The signal intensity of pleural and peritoneal fluids progressively increases following HBCA administration, independently of field strength and in the absence of biliary or vascular leakage. Because most patients who underwent Gd-BOPTA enhanced MR imaging had hyperintense fluid effusion during HBP, we do not recommend this contrast agent to diagnose biliary leakage.

CLINICAL RELEVANCE/APPLICATION

Because most patients who underwent Gd-BOPTA enhanced MR imaging show hyperintense fluid effusion during HBP, we do not recommend this contrast agent to diagnose biliary leakage.

SSQ07-07 Utility of the MDCT Scan Measurement of Gas Distended Gastric Volume Pre and Post Sleeve Gastrectomy and Its Correlation with 1-Year Weight Loss

Thursday, Nov. 30 11:30AM - 11:40AM Room: E350

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Measure gastric volume pre and postoperatively, and see its evolution over time. Correlate these volumes with weight loss. Determine if the resected or the residual stomach are predictors of weight loss.

METHOD AND MATERIALS

80 patients with BMI >40 kg/m2 or >35 kg/m2 and medical comorbidities underwent LSG between January 2012 and November 2016 and were analysed prospectively. 207 multislice computed tomography data sets acquired in those patients (52 female and 27 male) were evaluated for gastric volume with a dedicated examination protocol In each CT scan, the patient took diluted oral gastrografin (Sodium Amidotrizoate) mixed with sodium bicarbonate, to produce the gastric distension (from liquid plus air), until they feel repleted. Then the CT scan is performed with a thickness of 2mm and a max FOV, a specific 3D software is used for the reconstruction. CT scans were performed preoperatively and 2 months and 1 year after surgery. Parameters were compared to percentage of excess weight loss (%EWL) at 1 year.

RESULTS

Mean preoperative BMI of patients was 47.25 kg/m2, and mean preoperative stomach volume was 690.5 ml. A significant correlation was observed between preoperative gastric volume and preoperative weight (p=0,019 , r=0,401). One year after surgery the mean %EWL was 63.1% and the mean BMI was 35.5kg/m2. A significant correlation was found between the differences in volume of the stomach (preoperatively and 2 months and preoperatively and 1 year) and the %EWL. At 2 months after surgery, the mean difference in gastric volume was 567.8 ml with statistical correlation with the %EWL at 1 year (p=0,013 and r=0,504). At 1 year after surgery the mean difference in gastric volume was 499.5 ml, also with statistical correlation with %EWL at that moment (p=0,021 and r=0,444). No differences were found between the %EWL at 1 year and the remnant volume at 2 months (p=0,467 and r=0,182) or at 1 year (p=0,309 and r=0.198).

CONCLUSION

1. CT Scan pre and postoperatively, proved to be usefull and of great utility measuring the volume of the gas distended stomach. 2. There is a correlation between the differences in the volume of the stomach and the %EWL 1 year after surgery. 3. Gastric remnant volume changes over time.

CLINICAL RELEVANCE/APPLICATION

MDCT Scan can demonstrate in a precise way the changes in gastric volume over time and this data can help the surgeon to decide the best surgical approach.

SSQ07-08 Imaging of Gangrenous Appendicitis: Do Dual Energy Iodine Overlay Images Add Clinical Value?

Thursday, Nov. 30 11:40AM - 11:50AM Room: E350

Participants
Mohammed F. Mohammed, MBBS, Vancouver, BC (*Presenter*) Speaker, Siemens AG; Employee, X-Ray Teleradiology Services
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Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG

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PURPOSE

Appendicitis remains the most common acute surgical condition of the abdomen. One unique form of this disease is gangrenous appendicitis. This form carries a very high perforation risk which leads to an increase in morbidity and mortality.There have been numerous publications on the role of CT in the diagnosis of acute appendicitis, however the accuracy of CT in diagnosing gangrenous appendicitis is less established. In our study, we propose that the use of Dual Energy (DE) and spectral imaging techniques can improve diagnostic accuracy of acute gangrenous appendicitis.

METHOD AND MATERIALS

For this retrospective, IRB-approved study, the hospital RIS was queried for all abdominopelvic CT scans performed in the emergency department between January 1, 2013 to December 31, 2016 that were positive for appendicitis on histopathology. Non DECT studies and those with frank perforation, phlegmon or peri-appendicular abscess formation were excluded. A total of 236

cases were included in our study. 120 kVp simulated images and iodine overlay (IO) images were reviewed by two abdominal radiologists in a randomized fashion who were blinded to the results of the histopathology for presence of gangrene. Sensitivity, specificity, positive and negative likelihood ratios and interobserver agreement were calculated for each set of images. Confidence was rated on a 5 point Likert scale with 1 being completely uncertain and 5 being absolutely confident.

RESULTS

59.7 % (141) of patients were male. The mean age of patients was 43.5 ± 1.2 years. 51 patients (21.6 %) were positive for gangrenous appendicitis on histopathology.The sensitivity, specificity, positive and negative likelihood ratios, confidence and interobserver agreement for IO images were 100 %, 79.5 %, 4.6, 0, 5 and 0.99 respectively ($p < 0.0001$), compared to 21.6 %, 95.1 %, 4.4, 0.82, 3.75 and 0.98 respectively ($p < 0.0001$) for 120 kVp simulated images.

CONCLUSION

Review of IO images adds significant clinical value to the DECT of the abdomen and pelvis for assessment of acute appendicitis as well as the presence of gangrene within the appendix.

CLINICAL RELEVANCE/APPLICATION

IO images should be reviewed along side the simulated 120 kVp in cases of suspected appendicitis to diagnose or exclude presence of gangrenous appendicitis.

SSQ07-09 Dual Energy and Spectral CT Utilization Rates in Acute Abdominopelvic Imaging

Thursday, Nov. 30 11:50AM - 12:00PM Room: E350

Participants
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PURPOSE

The clinical applications of Dual Energy CT (DECT) in the abdomen and pelvis is well established. However, the actual utilization rates of DE/Spectral analysis are less well documented, specifically in the acute setting. Our study aims to assess the utilization rates of DECT in acute abdominopelvic imaging in the emergency department and the clinical value added by DE/spectral interrogation methods.

METHOD AND MATERIALS

For this retrospective, IRB-approved study, the hospital RIS was queried for all abdominopelvic DECT scans performed in the emergency department between January 1 to December 31, 2016. A total of 1238 studies were performed and were included in our study. The reports were reviewed for mention of DE/spectral interrogation as part of the interpretation of the study. Note was made of the number of times DE/spectral interrogation techniques altered management (by changing the diagnosis or detection of an unexpected, clinically relevant finding), confirmed an observation and increased confidence in the definitive diagnosis, provided additional relevant information or characterized an incidental finding - thus avoiding the need for further investigation.

RESULTS

DE/spectral analysis was utilized in 243 studies out of 1238 (19.63 %). DE/spectral analysis altered management in a significant way 10.3 % of interrogated cases, confirmed suspected observations and increased diagnostic confidence in 21 % of cases, provided relevant information on an observation in 66.7 % of cases and characterized an incidental finding in 18.1 % of cases.DE/spectral analysis was most commonly utilized in assessment of the genitourinary tract (68.5 %) followed by the gastrointestinal tract (20.6 %), the hepatobiliary system (7 %), the musculoskeletal system (2.25 %) and the vascular system (1.5 %).

CONCLUSION

There is good utilization of DE/spectral analysis in the acute setting, with nearly 1 out of 5 abdominopelvic DECT studies undergoing DE interrogation, adding clinical value to the examination by providing information that would have otherwise required additional imaging or other investigations. DE interrogation altered clinical management in 10 % cases.

CLINICAL RELEVANCE/APPLICATION

Routine utilization of DE/spectral techniques can impact management, improve diagnostic confidence and provide definitive clinically relevant diagnostic information only capable by DECT/spectral techniques.

SSQ08

Gastrointestinal (Oncology Imaging)

Thursday, Nov. 30 10:30AM - 12:00PM Room: E353A

GI OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Vahid Yaghmai, MD, Chicago, IL (*Moderator*) Nothing to Disclose
Steven S. Raman, MD, Santa Monica, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSQ08-01 Comparison of Guidelines for the Diagnosis of Hepatocellular Carcinoma Using Multidetector CT in Patients Undergoing Liver Transplantation

Thursday, Nov. 30 10:30AM - 10:40AM Room: E353A

Participants
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PURPOSE

To compare the diagnostic performance of multidetector CT (MDCT) among the guidelines based on the American Association for the Study of Liver Diseases (AALSD), the Liver Imaging Reporting and Data System (LI-RADS) 2014v, the Organ Procurement and Transplant Network (OPTN) system, and the Korean Liver Cancer Study Group-National Cancer Center (KLCSG-NCC) for the diagnosis of hepatocellular carcinoma (HCC) and allocation of liver transplantation (LT) candidates.

METHOD AND MATERIALS

From 2007 to 2014, 78 patients who underwent preoperative MDCT and subsequent LT for suspected HCC were included in this retrospective study. Two radiologists independently reviewed the CT images and evaluated focal hepatic lesions according to each guideline. Patients were allocated into one of three groups: beyond Milan criteria (MC), within MC with priority, or within MC without priority. The sensitivity and specificity of each guideline for detecting HCC, and accuracy of patient allocation were compared using logistic regression with the generalized estimating equation.

RESULTS

Fifty of 78 patients had 87 HCCs. For the detection of HCCs smaller than 1 cm (n = 24) and HCCs equal to or greater than 2 cm (n = 24), per-lesion sensitivity was not significantly different among four guidelines (P > 0.05). However, the sensitivity for detecting 1-2-cm HCCs (n = 39) was significantly higher when using the AASLD or the KLCSG-NCC guidelines (30.8-41.0%) than that using the LIRADS or the OPTN system (15.4-18.0%) (P = 0.030 for reader 1 and P = 0.005 for reader 2). Per-patient specificity was 92.3-96.2% using the AASLD or the KLCSG-NCC guidelines, and 92.3% using the LIRADS or the OPTN system without significant differences among four guidelines (P > 0.05). The accuracy for patient allocation was 74.4% in reader 1, and 71.8% in reader 2 without any difference among four guidelines in both readers.

CONCLUSION

The AASLD and the KLCSG-NCC guidelines can provide higher sensitivity than LIRADS and the OPTN system for the detection of 1-2-cm HCCs with MDCT. The accuracy for patient allocation was comparable among four guidelines.

CLINICAL RELEVANCE/APPLICATION

The AASLD and the KLCSG-NCC guidelines can improve the sensitivity for detecting 1-2-cm HCCs using CT compared with other two systems. Any of the four guidelines can be used for patient allocation.

SSQ08-02 Predicting HCC Microvascular Invasion (MVI) Using Imaging Morphological Criteria: Still a Lot to Know

Thursday, Nov. 30 10:40AM - 10:50AM Room: E353A

Participants
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PURPOSE

Predicting HCC MVI using TC and MRI morphological criteria.

METHOD AND MATERIALS

This study received the necessary IRB approval. From September 2009 to December 2015, 208 patients underwent to curative resection for HCC at our institution. Subsequently we excluded 73 patients without imaging at PACS, 25 patients without MVI information at the pathology report and 18 patients that underwent to surgery more than 90 days after performing CT or MRI.The final cohort was made up of 92 patients that performed 56 CT and 36 MRI.For each patient we reviewed retrospectively the imaging studies evaluating number of lesions, size of the biggest lesions, lesions margin, presence of capsule and peripheral enhancement. Therefore we compared these characteristics with the presence or the absence of MVI stated in the pathology report.

RESULTS

Of the 92 patients 31(33.7%) presented MVI at the pathology report. The retrospective review of the imaging studies showed that the 92 patients presented 1.4±0.9 nodules, the average size of the biggest lesion was of 4.9±4.3cm, 48 (52,2%) had irregular margins, 45 (48,9%) had capsule and 45 (48,9%) had peripheral enchainment.Size (p=0.003) and capsule (p=0.004) demonstrated correlation, using a univariate analysis, with MVI. Other criteria like number of lesions, margins and peripheral enhancement didn't show any correlation with MVI.Multivariate analysis confirmed these results showing and odds ratio of 4.5 and 6.8 for capsule and size >6cm respectively.

CONCLUSION

Size >6cm and presence of capsule are associated with MVI.

CLINICAL RELEVANCE/APPLICATION

MVI is an important prognostic factor for recurrence in patients with HCC: its imaging prediction can be useful for identifying patients with better survival after liver transplant.

SSQ08-03 Multiparametric PET/MRI of Hepatocellular Carcinoma: Synergy of Redundancy?

Thursday, Nov. 30 10:50AM - 11:00AM Room: E353A

Participants
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PURPOSE

To quantify multiparametric FDG-PET/MRI parameters in hepatocellular carcinoma (HCC) and to assess the correlation between mpMRI and FDG-PET SUV parameter values in liver parenchyma and HCC lesions.

METHOD AND MATERIALS

This prospective study, approved by the institutional review board, enrolled 15 HCC patients (M/F 12/3, mean age 61 years). The mpMRI protocol, performed simultaneously with an 18F-FDG-PET examination, consisted of BOLD-MRI, IVIM-DWI and DCE-MRI measurements. Quantitative parameter maps were generated [BOLD: R2* pre and post O2, ΔR2* (post-pre); IVIM: pseudodiffusion coefficient D*, diffusion coefficient D, perfusion fraction PF, ADC; DCE-MRI: Ktrans (Tofts model TM and shutter-speed model SSM), ve (TM&SSM), kep (TM&SSM), arterial fraction ART (TM&SSM), mean intracellular water molecule lifetime τi (SSM) and ΔKtrans (SSM-TM), the latter two potentially reflective of tissue metabolism]. Mean mpMRI parameters and PET parameters (SUVmean and SUVmax) in HCC lesions and liver parenchyma and SUV tumor/liver ratios SUVmean T/L and SUVmax T/L were calculated. Differences between PET/MRI parameters in liver and HCC were assessed using Wilcoxon signed-rank tests. Spearman correlations between PET and mpMRI parameters in liver, all HCC lesions and FDG-avid (SUVmean HCC > SUVmean liver) HCC lesions were determined.

RESULTS

21 lesions were analyzed [mean size 4 (range 2-13) cm] of which 11 were FDG-avid. Significantly higher ART (TM and SSM) and lower R2* (pre and post O2) values were found in HCC vs. liver (P<0.008). PET and MRI parameters did not correlate in liver. In HCC, Ktrans TM and SUVmax (r=-0.467, P=0.033) and ΔR2* and SUVmax (r=0.586, P=0.013) showed significant correlations. IVIM parameters significantly correlated with PET parameters in FDG-avid HCC lesions [D and SUVmean (r=-0.767, P=0.021); ADC and SUVmean (r=-0.800, P=0.014)]. SSM parameter ΔKtrans showed significant correlation with SUVmean T/L and SUVmax T/L (r=0.438-0.536, P<0.047).

CONCLUSION

Multiparametric PET/MRI seems synergistic for liver parenchyma characterization, while quantitative mpMRI showed significant correlations with FDG-PET SUV values in HCC.

CLINICAL RELEVANCE/APPLICATION

Multiparametric PET/MRI can potentially provide improved characterization of HCC lesions compared to the individual modalities.

SSQ08-04 Improper Timing of Portal Venous Phase Acquisition Causes Variability in Observed Tumor Density and Impacts Treatment Response Assessment: Metastatic Colorectal Cancer as a Paradigm

Thursday, Nov. 30 11:00AM - 11:10AM Room: E353A

Participants
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PURPOSE

New tumor response patterns to anticancer drugs have led to a response criteria shift from size to density. Choi criteria categorize response to anti-angiogenic therapies by a decrease in tumor density greater than 15% at the portal venous phase (PVP). We compared this threshold to the variability caused by both biology and image acquisition (improper PVP-timing) using liver metastases (LM) from colorectal cancer (CRC) as a paradigm.

METHOD AND MATERIALS

Pretreatment PVP CT images from a total of 291 LM-CRC patients from a single precision medicine trial were included. Four experienced radiologists independently scored the PVP timing and reached a consensus according to a 3-point scoring system: early/optimal/late PVP. Using radiologists' consensus, we trained a proprietary computer-aided quantitative quality control method to monitor PVP-timing. The reference standard was a computer-refined consensus. For each patient, we contoured target liver lesions and calculated their average density.

RESULTS

The PVP-timing was early, optimal and late in 52, 194 and 45 patients, respectively. The average (95CI) accuracy of the four radiologists for the detection of an optimal PVP-timing was 81.7% (78.3-85.2) and was outperformed by the 88.6% (84.8-92.4) computer-accuracy. The mean±SD LM-CRC density was 68±15HU overall and 59.5±14.9HU, 71.4±14.1HU, 62.4±12.5HU at early, optimal and late PVP-timing, respectively. LM-CRC density was thus decreased at non-optimal PVP-timing by 16.7% at early-PVP (p=8.9e-08) and 12.6% at late-PVP (p=1.8e-04) compared to that of optimal-PVP.

CONCLUSION

The 15%-threshold defined by Choi criteria is very sensitive for the detection of tumor response because non-optimal PVP-timing induces a similar decreased tumor density. Therefore, non-optimal PVP alters treatment response assessment and caution should be exercised in interpreting the significance of small density changes. Computer-aided quantitative PVP-timing scoring system outperforms radiologists' visual assessments and could improve the monitoring of anticancer therapy efficacy at patient and clinical trial level.

CLINICAL RELEVANCE/APPLICATION

Non-optimal PVP-timing causes variability in observed tumor density that can impact treatment response assessment defined by Choi criteria. We designed, by machine-learning, a computer-aided system for an optimized monitoring of anticancer drug efficacy.

SSQ08-05 One-Step Spectral and Perfusion CT Scan: Monitoring the Therapeutic Efficacy of VEGF Receptor Kinase Inhibitor AG-013736 in Rabbit VX2 Liver Tumors

Thursday, Nov. 30 11:10AM - 11:20AM Room: E353A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To develop a spectral contrast-enhanced CT protocol from perfusion CT data obtained with the same scan based on the time-attenuation curves and to evaluate its value in assessing the therapeutic efficacy of a vascular endothelial growth factor (VEGF) receptor inhibitor AG-013736 in rabbit VX2 liver tumors.

METHOD AND MATERIALS

The institutional animal care and use committee approved this study. In 31 VX2 liver tumor-bearing rabbits, a spectral CT protocol

The institutional animal care and use committee approved this study. In 31 VX2 liver tumor bearing rabbits, a spectral CT protocol was reconstructed to evaluate the maximum contrast of liver tumors by using time-attenuation curves from the perfusion CT data in the same scan. The iodine concentrations(ICs)of tumors derived from spectral CT normalized to aorta (nICs) at different time points (baseline, 2, 4, 7, 10 and 14 days after treatment) were compared within the treated group (n = 23) by using the Friedman test as well as between the control (n = 8) and treated groups by using the Mann-Whitney test. Correlations between nICs and perfusion parameters ,and between nICs and the tumor size, Bax,Bcl-2,VEGFR and VEGF mRNA were analyzed by using the Spearman rank test.

RESULTS

The optimal timing for maximum contrast of liver tumors in spectral CT was 15 seconds±2 in the arterial phase (AP) with the tumor CT values of 175-343HU. In AP, moderate correlations were found between nICs and time to peak (r=-0.588, P= 0.001) while substantial correlations were found between nICs and mean slope of increase (r= 0.672, P <0.001). The difference for nICs between each time point after treatment and baseline were significantly lower in the treated group than in the control group at 2 days after treatment. The greater decrease of nICs in tumors at 2 days in AP were positively correlated with smaller increase in tumor size at 14 days (r=0.69 , P<0.05). The tumor nIC values in AP had positive correlations with Bcl-2,VEGFR and VEGF mRNA (r values ranging from 0.58 to 0.76) and negative positive correlations with Bax (r= -0.56) (P<0.05 for all).

CONCLUSION

Iodine concentrations from spectral CT derived from perfusion CT data in AP were well correlated with perfusion CT parameter, which allowed early treatment monitoring the therapeutic effect of AG-013736 to liver tumors.

CLINICAL RELEVANCE/APPLICATION

Spectral CT can quantify the arterial tumor perfusion at a substantially lower radiation dose, and have good correlations with perfusion CT and histopathological findings.

SSQ08-06 Clinical Significance of T2* For Differentiating Tumor KRAS Mutation Status in Rectal Cancer

Thursday, Nov. 30 11:20AM - 11:30AM Room: E353A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To investigate the characteristics and potential differences of T2* in rectal cancers with different KRAS status.

METHOD AND MATERIALS

Totally, 119 patients, including 83 men and 36 women with histologically proved rectal cancer underwent pelvis MRI examination including T2 fast field echo (T2 FFE) sequence using five echoes. T2* values were automatically calculated after region of interest (ROI) being selected along the outline of whole tumor. Patients were stratified into two groups-KRAS wild-type and mutant by amplification refractory mutation system (ARMS) method. According to different mutation locations, patients with KRAS mutant were divided into codon 12 and codon 13 two subgroups. The T2* values between KRAS wild-type group and KRAS mutant group, codon 12 subgroup and codon 13 subgroup, were compared by using independent samples t test. Receiver operating characteristic(ROC) analysis of discrimination between KRAS wild-type and KRAS mutant rectal cancer was performed for T2* values. Intra- and interobserver agreement were evaluated using the intraclass correlation coefficient (ICC).

RESULTS

Our study included 76 KRAS wild-type, 43 KRAS mutant, and the latter group were then divided into 38 codon 12 patients and 5 codon 13 patients. Intra- and inter-observer reproducibility were relatively good to excellent for T2* (ICCIntra=0.8705, 95% confidence interval 0.8139~0.9099; ICCinter=0.7914, 95% confidence interval 0.7133~0.8501). T2* values were significantly higher in KRAS mutant group ([44.20±12.18]ms) than that in KRAS wild-type group ([36.27±11.96]ms) (t = -3.452, P = 0.001). However, T2* values showed no significant differences between codon 12 and codon 13 subgroups ([44.42±12.20]ms vs [36.27±11.96]ms; t =-0.325, P = 0.741). According to ROC curve, T2* values showed diagnostic significance with the AUC values of 0.706. The optimal cutoff values of 40.73ms for T2* resulted in (T2* valus of KRAS mutant rectal cancers were greater than this value) accuracy rate of 69.75%, sensitivity of 76.74%, specificity of 65.79%, positive predictive value of 55.93%, negative predictive value of 83.33%.

CONCLUSION

T2* values derived from T2 FFE sequence, as a promising biomarker, demonstrated potential clinical value in differentiating rectal cancers with different KRAS status.

CLINICAL RELEVANCE/APPLICATION

T2* values may be a useful imaging biomarker for differentiating rectal cancers with different KRAS status.

SSQ08-07 Preoperative N Stage Evaluation in Gastric Cancer Patients by MDCT: Can the Sum of the Short Axis Diameter of the Lymph Nodes be used for N Stage Evaluation?

Thursday, Nov. 30 11:30AM - 11:40AM Room: E353A

Participants

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PURPOSE

N staging is important in deciding the appropriate surgical treatment and in determining the prognosis of gastric cancer. In the N stage of gastric cancer, the accuracy of previous reports varies from 51% to 84%, because the definition of metastatic lymph node (LN) is different between studies using MDCT, and various cut-off values have been applied. In addition, the number of LNs seen in pathologic specimens tends to be higher than the number of LNs seen in CT. We have estimated that the sum of the sizes of LNs in CT can be proportional to the number of pathologic metastatic LNs. The purpose of this study was to compare the diagnostic performance of the sum of short axis diameter of lymph nodes (LN-sum) and the CT N stage of gastric cancer.

METHOD AND MATERIALS

Between January 2012 and December 2012, 127 consecutive patients who underwent preoperative MDCT and gastrectomy for gastric cancer were identified. We defined metastatic LN on MDCT as LN with a short axis >= 8mm. Regardless of size, LNs showing morphologic features such as central necrosis, heterogenous enhancement, nearly round shape (longitudinal/transverse diameter ratio <1.5), and clustered nodules were also considered as metastasis. We then calculated the LN-sum. The diagnostic value of LN-sum for distinguishing N stages was assessed by calculating the area under the receiver operating characteristic (ROC) curve. Sensitivity and specificity of N stage using LN-sum were generated using the optimal cut-off values. Also, conventional CT N stages of gastric cancer were made.

RESULTS

LN-sum showed significant correlation with the pathological N stage of gastric cancer (rho?=?0.70, p? **CONCLUSION**

Significant correlations exist among LN-sum in the N stage of gastric cancer. The LN-sum would be useful in the preoperative N staging of gastric cancer.

CLINICAL RELEVANCE/APPLICATION

The precise preoperative N stage in gastric cancer is of great importance in planning therapeutic strategies, so LN-sum could be used as a noninvasive imaging method for pre-operative N staging of gastric cancer.

SSQ08-08 Prediction of Intrahepatic Distant Recurrence after Radiofrequency Ablation of Hepatocellular Carcinoma: Role of CT Findings Indicating Portal Hypertension

Thursday, Nov. 30 11:40AM - 11:50AM Room: E353A

Participants
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PURPOSE

The purpose of this study is to determine whether the degree of portal hypertension(PH) assessed by CT findings could also predict intrahepatic distant recurrence(IDR) in patients with hepatocellular carcinoma(HCC) who received radiofrequency ablation(RFA).

METHOD AND MATERIALS

From August 2012 and April 2016, 78 patients who received RFA as initial treatment of HCC with available liver stiffness measurement(LSM) values prior to RFA were included, and the presence of IDR was reviewed. Two radiologists evaluate CT features : tumor size, multiplicity of tumors, and the sign of PH such as the diameter of main portal vein, splenic volume, the presence of gastroesophageal varices at risk of recurrence(GEV-R), and the amount of ascites. GEV-R was defined as the presence of esophageal varix and/or large gastric varix(>10mm) on CT. A LSM value and the fibrosis indices such as APRI and FIB-4 scores were also investigated. Recurrence free survival rate was calculated using Kaplan-Meier curve, and each parameter was evaluated using uni- and multivariate Cox proportion hazards regression analysis. For validation of model, we also performed the validation study with the patients who underwent RFA wihout the result of LSM during the same period(n=89).

RESULTS

During a median follow-up of 407 days, IDR was identified in 38.5% of the subject(30/78). On univariate analysis, tumor size, LSM, APRI score, and GEV-R were significantly associated with IDR. Subsequent multivariate analysis including all variables identified that tumor size and LSM were significant independent predictors of IDR. However, among the CT features only, GEV-R was significant independent predictor of IDR(HR=3.907; p=0.002) as well as tumor multiplicity(HR=2.790; p=0.030). On validation study, tumor multiplicity(HR=2.86; p=0.006) was the only significant independent predictor of IDR after RFA. GEV-R shows increased tendency of recurrence(HR=1.68; p=0.083).

CONCLUSION

GEV-R and tumor multiplicity on CT could be a non-invasive predictor of recurrence after RFA as well as LSM.

CLINICAL RELEVANCE/APPLICATION

Portal hypertension sign on CT scan, such as GEV-R, might be useful as non-invasive predictor for IDR after RFA for HCCs.

SSQ08-09 Quantitative Analysis of Diffusion-Weighted MRI and Contrast-Enhanced MRI for Estimating Histopathological Grade of Hepatocellular Carcinomas

Thursday, Nov. 30 11:50AM - 12:00PM Room: E353A

Participants
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PURPOSE

Diffusion-weighted MR images (DWI) and Contrast-enhanced MR images (CE-MR) have been reported to be helpful for estimating the histological differentiation of hepatocellular carcinoma (HCC). However, the clinical reverence of DWI and CE-MR for estimating histopathological grade of HCCs has not yet been comparatively assessed in a quantitative routine. The purpose of this study is to quantitatively assess the performance of the ADC value in DWI and the mean intensity value in arterial phase of CE-MR in estimating the grade of malignancy of HCC.

METHOD AND MATERIALS

Thirty-five pathologically confirmed HCC lesions from July 2012 to October 2015 were included in this retrospective study. Sixteen low grade tumor corresponds to Edmondson grade I and II, and nineteen high grade tumor corresponds to Edmondson grade III and IV. DWI and CE-MR were retrieved for each subject (Signa Excite HD 3.0T, GE Healthcare, Milwaukee, WI, USA) . Single-shot echo-planar DW imaging acquisitions were performed in the axial view with three b values (0,100,600 sec/mm2). ADC map was calculated by the mono-exponentially fitting model. The region of interest (ROI) extraction of HCCs in DWI and CE-MR was manually performed by an experienced radiologist (10 years of experience in abdominal radiology), using a free-form curve fitting technique. The performance of texture feature and ADC value in differentiating the biological aggressiveness of HCC was assessed using Receiver Operating Characteristic (ROC) analysis. $P<0.05$ was considered statistically significant.

RESULTS

Low grade HCCs showed a higher mean intensity value ($p=0.001$) and a comparable ADC ($p>0.05$), as compared with high grade HCCs. AUC, Accuracy, Sensitivity and Specificity were 0.714, 0.743, 0.688, and 0.789 for ADC in DWI, corresponding to 0.924, 0.914, 1.000, and 0.842 for the mean intensity value in CE-MR, respectively.

CONCLUSION

The Mean intensity of arterial phase images in CE-MR proves to be superior to the ADC value of DWI in the prediction of the histopathological grade of HCC.

CLINICAL RELEVANCE/APPLICATION

Our quantitative study indicates that the mean intensity in arterial phase of CE-MR is much better than the ADC value of current DWI in the performance of predicting the histopathological grade of HCC, which may aid clinical decisions and help with patient management in clinical practice.

SSQ09

Science Session with Keynote: Gastrointestinal (Liver Fibrosis)

Thursday, Nov. 30 10:30AM - 12:00PM Room: E353C

GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Kumaresan Sandrasegaran, MD, Indianapolis, IN (*Moderator*) Consultant, Guerbet SA
An Tang, MD, Montreal, QC (*Moderator*) Research Consultant, Imagia Cybernetics Inc; Speaker, Siemens AG
Sudhakar K. Venkatesh, MD, FRCR, Rochester, MN (*Moderator*) Nothing to Disclose

Sub-Events

SSQ09-01 Gastrointestinal Keynote Speaker: Status of Liver Fibrosis Imaging

Thursday, Nov. 30 10:30AM - 10:40AM Room: E353C

Participants
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ABSTRACT

LEARNING OBJECTIVES 1. To review the histological staging of liver fibrosis. 2. To discuss the classification of imaging-based techniques for assessment of liver fibrosis. 3. To highlight key unmet needs and potential future directions in liver fibrosis imaging. ABSTRACT Liver fibrosis is characterized by the accumulation of collagen and other extracellular matrix proteins as a result of repeated injury to the tissue due to chronic liver disease. In this keynote lecture, we will review challenges inherent to using liver biopsy for staging of liver fibrosis, including existence of numerous staging systems, sampling variability, and declining acceptance. We will provide a classification of imaging techniques implemented on US, CT, and MRI which evaluate changes in physical or physiological properties that accompany liver fibrosis. We will highlight key unmet needs in this field, including standardization of biomarkers across imaging systems, need for head-to-head comparison between techniques, and concomitant assessment of biological confounders (such as inflammation and steatosis).

SSQ09-02 Can "Simultaneous Multi-Angular Relaxometry of Tissue" and "Modified Look-Locker Inversion Recovery" T1 Mapping Magnetic Resonance Imaging Sequences Predict the Histopathologic Degree of Liver Fibrosis in Chronic Liver Disease?

Thursday, Nov. 30 10:40AM - 10:50AM Room: E353C

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Determination of the severity of the chronic liver disease (CLD) has a great importance for the decision of the management plan and to predict the prognosis. In this study, we aimed to introduce new magnetic resonance imaging (MRI) sequences for T1 mapping, Modified Look-Locker Inversion Recovery (MOLLI) and Simultaneous Multi-Angular Relaxometry of Tissue (SMART) sequences to predict the degree of liver fibrosis in patients with histopathologically proven CLD.

METHOD AND MATERIALS

Ninety-one cases (51 CLD and 40 control group) were prospectively enrolled in the study, and an MRI of the liver was performed by using a 32-channel body coil with a 1.5T MRI scanner (MR 450w, GE, Chicago, USA). SMART and MOLLI sequences were acquired to create T1 maps. Following the MRI study, a percutaneous ultrasound-guided core biopsy was performed from the parenchyma of the liver to determine the histopathological grade of liver fibrosis in the patient group. T1 mapping values of the liver were measured separately by two different observers independently by using nine separate circular "region of interests" and compared with the histopathological fibrosis grades. Intraclass correlation coefficient (ICC) method was used to assess the variability on

SMART and MOLLI sequences statistically.

RESULTS

ICC for assessing T1 values of the liver on SMART and MOLLI MRI sequences were excellent, yielding 0.982 and 0.960, respectively. SMART and MOLLI values in patients with CLD were significantly higher than the control group ($p < 0.001$). SMART and MOLLI values were positively and significantly correlated with the grade of fibrosis (Table 1). Receiver operating curve analysis showed that SMART sequence was superior to MOLLI sequence for the determination of the grade of the fibrosis (Table 2). The difference between ROC analysis of SMART and MOLLI measurement of observers were statistically significant ($p = 0.042$ and $p= 0.003$).

CONCLUSION

Both SMART and MOLLI sequences can be used for predicting the liver fibrosis in patients with CLD. However, SMART sequence has better diagnostic performance and ICC when compared to MOLLI sequence values.

CLINICAL RELEVANCE/APPLICATION

SMART and MOLLI T1 mapping MRI sequences may have a role for the noninvasive determination of the degree of liver fibrosis which will improve the management plan.

SSQ09-03 Grading of Hepatic Fibrosis using Iodine Map of Spectral Liver CT

Thursday, Nov. 30 10:50AM - 11:00AM Room: E353C

Participants
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PURPOSE

To determine whether iodine map from spectral computed tomography (CT) is able to provide hepatic extracellular volume fractions (fECVs) for grading hepatic fibrosis (HF).

METHOD AND MATERIALS

A total of 57 patients (M:F=42:15, mean age, 54.3 ± 11.9 years) histologically diagnosed with HF underwent quadriphasic liver CT at the scanner with spectral detector (IQon, Philips Healthcare) at 120kVp. Delayed phase was obtained 3 minutes after standard dose of contrast media administration. On the generated iodine maps of iodine, approximately 0.8-1cm2 round regions of interest (ROIs) were drawn avoiding focal lesion and vessels in the liver, and aorta for calculating fECV as follows: fECV (%) = Iodine concentration liver (mg/ml*)/ Iodine concentration aorta (mg/ml*)x (100-Hematocrit [%]). Correlation between fECV and HF stage was evaluated using Spearman's correlation coefficient. fECVs, iodine concentration and effective Z were compared between F0-1 (n=7), F2-3 (n=17) and F4 (n=33), and between F0-3 and cirrhosis (F4).

RESULTS

fECVs showed a moderate correlation with pathologic HF staging ($r=0.55$, $P<0.0001$). fECV was higher in F4 than F2-3 (36.0±8.0% vs. 26.4±4.1, $P<0.01$) but there was no significant difference between F2-3 and F0-1 (28.8±3.7%, $P>0.05$). In comparison between F0-3 and F4, F4 showed significantly higher fECV than F0-3 (36.0±8.0% vs. 27.7±4.2%, $P<0.0001$). In addition, iodine density of the liver (mg/ml*) was significantly higher in F4 than F0-3 (1.87±0.28 vs. 1.63±0.33, $P=0.006$). Effective Z was also higher in F4 than F0-3 (8.42±0.16 vs. 8.31±0.20, $P=0.026$), but there was a substantial overlap of the values.

CONCLUSION

Iodine map of delayed phase from the spectral CT enables to estimate fECV and fECV increased as HF progressed and F4 showed significantly higher fECV than F0-3.

CLINICAL RELEVANCE/APPLICATION

Iodine map can be generated from single phase of routine exam at spectral CT, and it can provide quantitative information regarding HF, without additional contrast media use or scan acquisition.

SSQ09-04 Two-dimensional Shear Wave Elastography for Grading Liver Fibrosis using a Confidence Map: Are Liver Stiffness Measurements Accurate without Breath-holding?

Thursday, Nov. 30 11:00AM - 11:10AM Room: E353C

Participants
Isabelle Durot, MD, Stanford, CA (*Presenter*) Nothing to Disclose
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Juergen K. Willmann, MD, Stanford, CA (*Abstract Co-Author*) Research Consultant, Bracco Group Research Grant, Siemens AG Research Grant, Bracco Group Research Grant, Koninklijke Philips NV Research Grant, General Electric Company Advisory Board, Lantheus Medical Imaging, Inc Advisory Board, Bracco Group

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PURPOSE

Ultrasound elastography of the liver for grading liver fibrosis needs to be performed in a resting respiratory position as forceful inspiration or expiration can falsify values. However, in patients with comorbidities optimal breath-holding can be challenging despite coaching. The aim of this study was to assess whether liver stiffness measurements using two-dimensional (2D) shear wave

elastography (SWE) along with a novel confidence map yield similar results in patients with and without breath-holding.

METHOD AND MATERIALS

Liver stiffness measurements were performed in 25 consecutive patients with chronic liver disease (7 non-alcoholic fatty liver disease, 5 hepatitis B, 4 hepatitis C, 4 alcoholic cirrhosis, 2 hemochromatosis; 3 others) by using 2D SWE (prototype software ElastQ; EPIQ7; Philips). In the same imaging session and in each patient, two 6-sec cine loops were obtained each either in resting respiratory position or during free quiet breathing. For each data set, 10 circular regions of interest (ROI; 0.791cm2) were drawn at 2 cm below the liver capsule in the middle of the field of view. A confidence map that automatically highlights areas without breathing artifacts was used to guide ROI placements. The mean and median shear wave velocities obtained by the two methods were compared using the Bland-Altman methodology and concordance correlation.

RESULTS

In both groups, the median shear wave velocity was 1.23 m/s with a concordance correlation of 97% (95%CI; 94-98%) and Bland-Altmann 95% limits of agreement of -0.17 and 0.12. The mean velocity in the breath-hold group was 1.36 m/s and in the free-breathing group 1.34 m/s with a concordance correlation of 97% (95%CI: 94-99%) and Bland-Altmann 95% limits of agreement of -0.17 and 0.12.

CONCLUSION

In 2D SWE using a confidence map for ROI placements, liver stiffness measurements are comparable with and without breath-holding.

CLINICAL RELEVANCE/APPLICATION

The possibility of free breathing makes 2D SWE exams more robust and clinically practical, in particular in patients with difficulties holding their breath in a resting respiratory position.

SSQ09-05 A Prediction Model for Survival in Patients with Cirrhosis by Using Abdominal CT Findings: Compared with MELD Scoring System

Thursday, Nov. 30 11:10AM - 11:20AM Room: E353C

Participants
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Young Kon Kim, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Model for End-stage Liver Disease (MELD) score was developed as a disease severity index for patients with liver cirrhosis (LC) awaiting liver transplantation. Although MELD score is known to be better than Child-Turcott-Pugh score for predicting survival, there are still some limitations. Imaging study contains important information of LC and portal hypertension, and there have been attempts to measure the related imaging parameters. We have tried to establish a new model with abdominal CT for prediction of survival in patients with LC and compare it with MELD score.

METHOD AND MATERIALS

145 patients diagnosed with LC and underwent abdominal CT were included retrospectively. Two radiologists measured the imaging parameters, such as maximum diameters of main portal vein (øMPV), superior mesenteric vein (øSMV), splenic vein (øSV), and estimated splenic volumes. The grade of esophageal, paraesophageal, gastric varices and amount of ascites were also evaluated. Statistically significant CT features related to overall survival were used to establish a model to calculate risk scoring system using multivariate Cox proportional hazard regression and validated this system with data (n=88) of another hospital. To compare the accuracy of two scoring systems, time-dependent C statistics was used.

RESULTS

øSMV/øSV, splenic volume, esophageal varices grade and amount of ascites were significant predictors of survival, and risk score was calculated by following formula: 0.79×øSMV/øSV + 0.001×splenic volume + 1.00×grade 1 esophageal varix(EV) + 0.57×grade 2EV + 1.32×grade 3EV + 1.45×moderate ascites + 2.16×large ascites - 2.07. Patients with same or higher risk scores than 1.74 had significantly poor overall survival rates ($p<0.001$), with median survival of 7 months. Also in validation set, patients with high risk scores (>= 1.74) had significantly poor overall survival rates ($p=0.02$). Time-dependent AUC showed MELD score was superior to imaging model for the first 20 months, but after 50 months, imaging model was better (c-index of imaging and MELD score, 0.768 and 0.735, respectively). Also, in validation set, imaging score was superior to MELD score after 20 months (c-statistics, 0.732 and 0.681, respectively).

CONCLUSION

In patients with LC, this imaging model may be useful in predicting long-term survival compared to MELD score.

CLINICAL RELEVANCE/APPLICATION

A prediction model with abdominal CT may be useful in predicting long-term survival in patients with LC.

SSQ09-06 Point Shear Wave Elastography for Grading Liver Fibrosis: Can the Number of Measurements be Reduced?

Thursday, Nov. 30 11:20AM - 11:30AM Room: E353C

Participants
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Research Grant, Bracco Group Research Grant, Koninklijke Philips NV Research Grant, General Electric Company Advisory Board, Lantheus Medical Imaging, Inc Advisory Board, Bracco Group

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PURPOSE

To assess whether the number of point shear wave elastography (pSWE) measurements of the liver could be reduced to 5 vs. the currently recommended 10 measurements in patients with chronic liver diseases.

METHOD AND MATERIALS

In 1412 patients with chronic liver disease (694 hepatitis B, 499 hepatitis C, 62 non-alcoholic fatty liver disease, 35 primary biliary cholangitis, 24 post liver transplantation, 18 autoimmune hepatitis, 15 alcoholic cirrhosis, 14 cardiac cirrhosis, 51 others) pSWE measurements were performed on a S2000 scanner (Siemens) following the protocol recommended by the Society of Radiologists in Ultrasound (SRU) with 10 consecutive valid measurements obtained in liver segment 8. Liver fibrosis grading using published cut-off values were compared using 10 vs. 5 measurements with Kendall's tau coefficient and the exact test of symmetry.

RESULTS

The median shear wave velocities using 5 measurements was 1.27 m/s compared to 1.26 m/s using 10 measurements. Overall fibrosis grading highly correlated when using 5 vs. 10 measurements (tau=0.96; P<0.001). Similarly, there was high correlation when grading clinically significant (>= F2) vs. non-significant (F0/1) fibrosis (tau=0.95; P<0.001). A change in grading was observed in 34/1412 patients (2.4%; 95%CI; 1.7-3.3%) of exams when classifying clinically significant from non-significant fibrosis. Changes in grading occurred primarily when velocities ranged between 1.1 and 1.5 m/s. When the median values from 5 measurements were either <1.1 or >1.5 m/s (in 794 patients; 56%), a change of grading was observed in 0/1412 measurements (0%; 95%CI; 0-0.4%).

CONCLUSION

Clinically significant changes in grading liver fibrosis using only 5 measurements was observed in only a small portion of patients. In patients with known F0 or F4 fibrosis, 5 measurements may be sufficient on surveillance ultrasound elastography exams.

CLINICAL RELEVANCE/APPLICATION

Five instead of 10 measurements may decrease scanning time, cost, and discomfort in both sonographers and patients.

SSQ09-07 Novel Mapping of Fibrosis and Hepatic Inflammation in NASH Patients with Dual R2 MRI Relaxometry

Thursday, Nov. 30 11:30AM - 11:40AM Room: E353C

Participants
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PURPOSE

Hepatic inflammation and fibrosis are two of the most important factors for the stratification, treatment and prognosis of patients with liver disease. Our objective is to evaluate a MRI multi-component relaxometry (MCR) technique to map fibrosis and inflammation in patients with non-alcoholic steatohepatitis (NASH). The extracellular water fraction (ECWF) was investigated for fibrosis, and the ratio of the transverse relaxation rate (R2) between intra and extra-cellular water (R2I/E) was assessed for inflammation.

METHOD AND MATERIALS

101 NASH diagnosed patients with liver biopsy were selected within 6 months for MRI exam. A 3T Philips Achieva was used with a multi-spin echo sequence. The images were analysed by a radiologist and physicist with over 12 years experience in abdominal imaging. The biopsies were reviewed by a pathologist with 14 years experience using the NASH-CRN score. 15 volunteers with normal lab results and no known liver disease were used for control.

RESULTS

The mean ECWF for the 101 NASH patients was 24.5(±3.1)% and 18.7(±1.6)% for the 15 volunteers. There was a significant correlation between ECWF and fibrosis stage (rs=0.83, p<1.0-06). In distinguishing healthy from fibrotic patients we achieved an AUROC of 0.98, with a sensitivity of 93% and specificity of 94% for a threshold ECWF of 20.6%. There was a significant difference between all stages of fibrosis by ECWF (p<0.001).The mean R2I/E for the 101 NASH patients was 3.2(±0.6) and 2.4(±0.3) for the 15 volunteers. For distinction of normal parenchyma from any lobular inflammation we achieved an AUROC of 0.91, with sensitivity of 83% and specificity of 83% at an R2I/E threshold of 2.7.

CONCLUSION

ECWF demonstrated very good performance in quantifying all stages of fibrosis, whereas R2I/E correlated more strongly with inflammation. The maps and distributions of ECWF and R2I/E also allow assessment of heterogeneity in liver pathology.

CLINICAL RELEVANCE/APPLICATION

The excellent performance of MRI ECWF in quantifying the earliest stage of NASH promises better selection of patients for biopsy.

Assessing inflammation with R2I/E offers an additional tool for patient selection. ECWF and R2I/E offer biomarkers of liver fibrosis and inflammation that are independent of field strength, are obtained without contrast or radiation, and help in the diagnostic and follow-up of NASH patients.

SSQ09-08 Reversibility of HCV-Related Liver Disease and Sustained Virology Response after Interferon-Free Antiviral Therapy

Thursday, Nov. 30 11:40AM - 11:50AM Room: E353C

Awards
Student Travel Stipend Award

Participants
Elena Lopez Banet, MD, Murcia, Spain (*Presenter*) Nothing to Disclose
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PURPOSE

The aim of this study was to assess:the evolution of hepatitis C-related liver disease by comparing analytical and elastography data before and after treatment with new antiviral agents.

METHOD AND MATERIALS

For this prospective study, we conducted a:randomized sampling of patients with hepatitis C virus (HCV) who had completed treatment with new drugs between May 2015 and March 2016. It was required that all patients included had undergone blood tests, viral load, liver B-mode ultrasonography and ARFI elastography with the determination of shear wave velocity (SWV) before starting treatment. These tests were repeated after a year of the completion of treatment for comparing results. The criteria for exclusion were as follows: coinfection with other hepatitis viruses or human immunodeficiency virus, liver transplant, alpha-1 antitrypsin deficit, metal deposition diseases and alcohol consumption of greater than 20g/day. Finally, we obtained 100 patients. Comparisons of means were performed using Student t-test for matching data. A p value of <0.05 was considered significant.

RESULTS

It was verified:a significant decrease of liver ARFI values since the average shear wave velocity declined from 1.98 to 1.66 m/s ($p<0.01$), which meant an improvement of liver parenchymal injury associated to HCV.Furthermore, it was determined reversibility in METAVIR stages, specially in F>=3 and F>=4 levels, in which more than half of patients improved their METAVIR stage after treatment ($p<0.05$).Moreover, sustained viral response was confirmed in all patients as well as an improvement of analytical data with hepatic profile (Alanine aminotransferase- ALT-, Aspartate aminotransferase -ALT-) ($p<0.05$).:

CONCLUSION

It has been verified a significant improvement of analytical and structural liver parameters in patients with HCV-related hepatic fibrosis who underwent treatment with interferon-free antiviral therapies.

CLINICAL RELEVANCE/APPLICATION

Reversibility of liver stifness after treatment might be monitored with ARFI elastography and it is essential for prognosis and management of these patients.

SSQ09-09 A Deep Convolutional Neural Network for the Prediction of METAVIR Score Using B-Mode Ultrasonography Images

Thursday, Nov. 30 11:50AM - 12:00PM Room: E353C

Participants
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PURPOSE

Liver fibrosis is one of the most important prognostic factors in patients with chronic liver disease. We developed a deep convolutional neural network (CNN) for the prediction of METAVIR score using B-mode ultrasonography (US) images.

METHOD AND MATERIALS

Among 7,273 patients with 140,605 B-mode US images, who had undergone either histopathologic examination or transient elastography, 2,798 patients with 5,517 B-mode US images were used for training the CNN. METAVIR score of the specimens, determined by pathologists specializing in liver pathology, and estimated METAVIR score derived from transient elastography were used as reference standards. Our training model (S-Detect for liver quantification) was based on the Visual Geometry Group-16 neural network with image appearance normalization technique. Two-class (F0, F1, F2, F3 vs. F4) and four-class (F0 vs. F1 vs. F23 vs. F4) models were developed. After training, 675 patients' images were tested to evaluate the models' performance in classifying the images to the correct METAVIR score.

RESULTS

Performance of the two-class model was as follows: sensitivity 81.6%, specificity 96.4%, and accuracy 88.3%. Performance of the four-class algorithm was as follows: sensitivity 64.5%, specificity 89.0%, and accuracy 72.7%. The expected METAVIR score was

displayed in the application within 2 seconds of analysis on average.

CONCLUSION

The engineered deep CNN-based METAVIR score prediction system revealed remarkable diagnostic accuracy using B-mode US images.

CLINICAL RELEVANCE/APPLICATION

This technology can assist radiologists in identifying the degree of liver fibrosis in a convenient fashion, leading to reduction in time and labor costs, while also providing a means for objective evaluation of liver fibrosis.

SSQ10

Science Session with Keynote: Genitourinary (Imaging of Gynecological Malignancy)

Thursday, Nov. 30 10:30AM - 12:00PM Room: E353B

GU MR OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Elizabeth A. Sadowski, MD, Madison, WI (*Moderator*) Nothing to Disclose
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Sub-Events

SSQ10-01 Genitourinary Keynote Speaker: The Added Value of MRI in Evaluation of Gynecological Malignancies

Thursday, Nov. 30 10:30AM - 10:40AM Room: E353B

Participants
Evis Sala, MD, PhD, New York, NY (*Presenter*) Nothing to Disclose

SSQ10-02 Clinical Application of PET/MR in Staging of Cervical Cancer and Diagnosis of Pelvic Lymph Node Metastasis

Thursday, Nov. 30 10:40AM - 10:50AM Room: E353B

Participants
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PURPOSE

The present study aimed to evaluate the clinical value of PET/MR in the staging of cervical cancer and diagnosis of pelvic lymph node metastasis.

METHOD AND MATERIALS

Seventy patients with cervical cancer were prospectively enrolled. Pelvic PET/MR scan and whole-body PET scan were performed before treatment. All images were evaluated by two experienced radiologists using a randomized, double-blind method. The diagnostic consistency of PET/MR staging, clinical staging, and gold standard staging of cervical cancer was evaluated with the Kappa consistency test, and the diagnostic consistency between each two methods was calculated. The difference between PET/MR staging and clinical staging was evaluated with the paired chi-square test ($P<0.05$). The value of PET/MR in the diagnosis of pelvic lymph node metastasis of cervical cancer was analyzed using diagnostic consistent rate, sensitivity, specificity, positive predictive value, and negative predictive value. The statistical software SPSS 19.0 was used in the analyses.

RESULTS

The consistency between PET/MR staging and the gold standard method for the diagnosis of cervical cancer was 91.43%. Kappa analysis indicated that the consistency between PET/MR staging and gold standard staging was satisfactory (kappa = 0.908). The consistency between clinical staging and gold standard staging of cervical cancer was fair (Kappa = 0.542). There was a significant difference between pre-treatment PET/MR staging and clinical staging ($X2 = 9.278$, $P<0.05$). In the patient-based analysis, the accuracy of PET/MR diagnosis of pelvic lymph node metastasis was 95.71%, sensitivity was 95.65%, and specificity was 95.74%. In the lymph node-based analysis, the accuracy, sensitivity, and specificity of PET/MR diagnosis were 97.61%, 92.16%, and 98.13%, respectively.

CONCLUSION

The diagnostic value of PET/MR for the staging of cervical cancer is significantly superior to clinical staging, and the former can be used as a one-stop diagnostic method for cervical cancer by accurately diagnosing and identifying pelvic lymph node metastasis.

CLINICAL RELEVANCE/APPLICATION

PET/MR without gadolinium administration will stage cervical cancer and identify pelvic lymph node metastasis accurately, and is strongly recommended as a one-stop diagnostic method in cervical cancer.

SSQ10-03 How to Differentiate Benign Atypical Myomas from Malignant Uterine Sarcomas Using MR Imaging

Thursday, Nov. 30 10:50AM - 11:00AM Room: E353B

Participants
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PURPOSE

To retrospectively evaluate MRI charateristics to differentiate malignant uterine sarcomas from benign myomas with atypical presentation on MRI.

METHOD AND MATERIALS

IRB-approved monocentric case-control study including 113 women (51 sarcomas and 62 atypical myomas) with an atypical uterine mass on MRI were underwent before surgery. Clinical and MRI data (heterogeneity on T2-weighted and diffusion sequences, ADC and perfusion curves relative to outer myometrium) were collected and compared with pathological findings.

RESULTS

Only 50% of sarcomas presented as a single uterine mass. Predictive criterias for malignancy were age (64 vs 48 years, p <0.0001), menopausal status (84% vs 20%, p <0.0001, OR = 20.82), irregular contours (73% vs 5%, p <0.0001; OR = 46.69), intra-tumoral hemorrhage (38% vs 13%, p = 0.003), high signal greater than the endometrium on DWI (100% vs 16%, p <0.0001 OR = 12.01), ADC (0.7 vs 1, 2.10-3 mm^2 / s, p <0.0001). Conversely, the presence of a portion, even partial, with low T2 signal or a type I perfusion curve had a VPN of 100% (p <0.0001).

CONCLUSION

Beyond the previously known clinical and morphologic criteria, adding functional sequences on MRI better differentiates malignant sarcomas from atypical myomas.

CLINICAL RELEVANCE/APPLICATION

Diffusion and perfusion MRI sequences may allow better predicting malignancy when facing an atypical uterine mass, to guide optimal therapeutic management.

SSQ10-05 Accuracy of Time Intensity Curves Generated From 4-Point DCE MRI in Differentiating Benign and Malignant Adnexal Lesions

Thursday, Nov. 30 11:10AM - 11:20AM Room: E353B

Participants
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Caroline Reinhold, MD, MSc, Montreal, QC (*Abstract Co-Author*) Consultant, GlaxoSmithKline plc

PURPOSE

To assess the accuracy of time intensity curves (TIC) generated from 4-point dynamic contrast-enhanced magnetic resonance imaging (DCE MRI) in differentiating benign and malignant ovarian lesions with solid tissue.

METHOD AND MATERIALS

Patient consent was waived by the Ethics Review Board for this retrospective study. From April 2006 to January 2017, 98 patients with ovarian DCE MRI studies with evidence of solid tissue at MRI were included (45 benign, 10 borderline and 43 malignant lesions). Semiquantitative analysis of signal intensity (SI) over time curves was performed using region-of-interest on the most enhancing solid tissue. TICs were classified according to three patterns of enhancement: a minimal increase with no well-defined shoulder "type 1, benign." A moderate initial rise in the SI of solid tissue relative to myometrium "type 2, borderline." An initial rise in the SI of solid tissue that was equal or steeper than myometrium "type 3, malignant". In patients with hysterectomy (n=11), the lesion SI was normalized to psoas and compared to a standard normalized myometrium curve. Standard of reference was histopathology in all patients.

RESULTS

Accuracy, sensitivity, specificity, PPV, and NPV of TIC for differentiating benign from malignant/borderline lesions was 85.9%, 96.2%, 74.5%, 80.6% and 94.6% respectively. TIC yielded comparable results to prospective clinical radiological diagnosis using standard morphological assessments (acc 85.7%, sens 93.9%, spec 80.0%, PPV 76.7%, NPV 94.9%). However, out of the 12 misdiagnosed patients during the clinical reads, (2 false negatives, 10 false positives), TIC was able to accurately reclassify 6 of them, resulting in an overall acc 93.9%, sens 100%, spec 87.5%, PPV 89.3%, NPV 100%.

CONCLUSION

The enhancement patterns of ovarian lesions on 4-point DCE MRI can help distinguish between benign and borderline/malignant tumors. Although pharmacokinetic parameters have been proposed by research-based groups, they have not been widely adopted or validated in the clinic. TIC based on 4-point DCE MRI can be a useful adjunct to standard qualitative morphological reads, with

the potential to improve diagnostic accuracy.

CLINICAL RELEVANCE/APPLICATION

Time intensity contrast-enhanced curves generated from 4-point DCE MRI are a useful adjunct to standard morphological imaging and can improve the accuracy for discriminating between benign and malignant ovarian lesions.

SSQ10-06 Amide Proton Transfer Imaging of Early Radiotherapy Response in High-Risk HPV+ Gynecologic Cancer

Thursday, Nov. 30 11:20AM - 11:30AM Room: E353B

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PURPOSE

HPV-associated gynecologic cancers are treated primarily with radiation, with cervical cancer being the most common cancer among women in the developing world. Anatomical MRI can be challenging to interpret following radiation when the morphological appearance of residual or early recurrent tumor tissue mimics post-radiotherapy inflammation and/or fibrosis. Amide proton transfer (APT) MRI, a subset of chemical exchange saturation transfer (CEST) MRI, has the potential to provide molecular information regarding tissue pH and mobile protein content, which may be beneficial in distinguishing radiation necrosis from recurrent disease. Necrotic lesions should demonstrate less cytosolic protein and peptide content as a result of the loss of cytoplasm compared to viable tumor tissue. We investigated the prognostic value of APT MRI following radiothearpy in a murine model of high risk HPV+ cervical cancer.

METHOD AND MATERIALS

A clinically relevant HPV+ orthotopic cervical cancer model was developed that expresses the E6 and E7 oncogenes of HPV-16 and the Ras oncogene. 4 animals received 9 Gy radiation and were imaged on days -1 and +1. A CEST-RARE pulse sequence was used with a 3 second saturation period consisting of a 2.0 uT continuous wave saturation pulse. 40 saturation frequencies between +5 and -5 ppm were acquired to generate a CEST spectrum in 8 minutes on a 7T Bruker MRI (Bruker Corporation, Billerica MA). Pixelwise analyses of magnetization transfer asymmetry (MTRasym) was performed to measure mobile protein content.

RESULTS

Preliminary results show that MTRasym measurements decreased the day after radiation treatment indicating a decrease in mobile protein content. This result supports the hypothesis that necrotic lesions have less cytosolic protein content than viable tumor, which can be detected with APT MRI.

CONCLUSION

Initial results indicate that as early as one day after radiation treatment, APT MRI can be used to distinguish necrotic tissue vs. viable tumor through a decrease in MTRasym. Additional mice will be imaged to confirm this trend and determine statistical significance.

CLINICAL RELEVANCE/APPLICATION

These findings may be beneficial to clinicians in identifying a new functional MRI technique to monitor early radiotherapy response of HPV+ gynecologic cancers.

SSQ10-07 Preoperative Tumor Texture Analysis from MRI Predicts High-Risk Status and Reduced Survival in Endometrial Carcinomas

Thursday, Nov. 30 11:30AM - 11:40AM Room: E353B

Participants
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PURPOSE

Tumor heterogeneity is a key feature of malignant disease. Heterogeneity at MRI can be quantified by texture analysis. We aimed to explore whether high-risk clinical and histological features in endometrial cancer are reflected in tumor texture parameters from preoperative MRI, and to assess the prognostic value of tumor texture parameters.

METHOD AND MATERIALS

Preoperative pelvic MRI (1.5T) including contrast-enhanced (CE) T1-weighted, T2-weighted and diffusion-weighted imaging was

Preoperative pelvic MRI (1.5T) including contrast-enhanced (CE) T1-weighted, T2-weighted and diffusion-weighted imaging was performed in 180 patients with histologically confirmed endometrial carcinomas. Using the software TexRAD, tumor regions of interest (ROIs) were manually drawn on the slice displaying the largest cross-section tumor area. Histogram based texture parameters (standard deviation, entropy, mean of positive pixels (Mpp), skewness and kurtosis) were calculated from these tumor ROIs on non-filtered and filtered images. The derived texture parameters were included in multivariate logistic regression models assessing their predictive value for identifying high tumor grade, deep myometrial invasion (DMI), cervical stroma invasion (CSI) and lymph node metastases. Preoperative histological risk from biopsy, conventional MRI findings and MRI-measured tumor volume were included as covariates, and the best cutoff values of texture parameters were determined by ROC curve analysis. Multivariate Cox regression was used for survival analysis.

RESULTS

High entropy in ADC-maps independently predicted DMI (OR 5.1, p=0.001), low Mpp in T2 images independently predicted CSI (OR 3.5, p=0.01) and high Mpp in CE T1 images independently predicted high grade (OR 3.5, p=0.005). High kurtosis in CE T1 images independently predicted reduced recurrence- and progression-free survival (HR 1.5, p<0.001). Different levels of filtration, including no filtration, were represented among the high ranked texture parameters.

CONCLUSION

MRI derived tumor texture parameters, reflecting tumor heterogeneity, independently predict high tumor grade, deep myometrial invasion, cervical stroma invasion and reduced survival in endometrial carcinomas. Thus, tumor texture parameters based on MRI represent promising biomarkers to aid preoperative tumor characterization for risk stratified surgical treatment.

CLINICAL RELEVANCE/APPLICATION

Tumor texture features at MRI are associated with high-risk phenotype and may aid preoperative risk classification for stratified surgery in endometrial cancer.

SSQ10-09 Machine Learning to Differentiate Uterine Sarcoma from Leiomyoma with High Signal Intensity on T2-Weighted Imaging Based on Multi-Parametric Magnetic Resonance Quantitative Imaging Features

Thursday, Nov. 30 11:50AM - 12:00PM Room: E353B

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PURPOSE

To determine whether a prediction model using machine learning based on quantitative multi-parametric magnetic resonance imaging (MRI) features has adequate diagnostic performance for differentiating uterine sarcomas from benign leiomyomas with high signal intensity on T2-weighted imaging (T2WI).

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board. The need for informed consent was waived. We included 62 patients who underwent pelvic 3T MRI examination for evaluation of uterine myometrial smooth muscle masses with high signal intensity on T2WI. Of the 62 patients, 38 had benign leiomyoma and 24 had uterine sarcoma. Age, tumor size, and 12 histogram and texture parameters (minimum, mean, standard deviation of, and maximum normalized signal; skewness; kurtosis; homogeneity; energy; contrast; correlation; entropy; and dissimilarity) were assessed on T1WI, T2WI, ADC maps, and contrast-enhanced T1WI. We developed a prediction model with machine learning (extreme gradient boosting) and calculated the area under the receiver operating characteristic curve (AUC) of this model by 10-fold cross validation, and compared the performance of this model with two board-certified radiologists.

RESULTS

Age had the highest importance (myoma, 43.8±9.9; sarcoma, 59.2±15.5; p=0.0001), followed by the minimum normalized T2 signal (myoma, 0.35±0.45; sarcoma, 0.82±0.54; p=0.0009), ADC skewness (myoma, 0.33±0.85; sarcoma, 0.86±0.89; p=0.0237), mean ADC (myoma, 1.56±0.40; sarcoma, 1.29±0.33; p=0.0057), and T2WI correlation (myoma, 0.86±0.08; sarcoma, 0.91±0.04; p=0.0041). In the validation analysis, the AUC of the machine learning is significantly higher than two radiologists (0.92 vs. 0.75 and 0.64, respectively; p<0.001).

CONCLUSION

Age was the most important factor for differentiation of uterine sarcoma from myoma with high-signal intensity on T2WI. The performance of machine learning was superior to that of experienced radiologists.

CLINICAL RELEVANCE/APPLICATION

Machine learning based on patient age and the texture of multi-parametric MRI has adequate diagnostic performance for differentiating uterine sarcoma from myoma with high signal intensity on T2WI.

RSNA 2017 Explore. Invent. Transform.
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SSQ11

Informatics (Radiomics and Quantitative Imaging)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S403A

BQ IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSQ11-01 Variation in Algorithm Implementation between Quantitative Texture Analysis Software

Thursday, Nov. 30 10:30AM - 10:40AM Room: S403A

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PURPOSE

Several open-source texture analysis software packages have recently been developed to address the increased need for quantitative image analysis. This study quantifies the variation in these features due to differences in algorithm implementation.

METHOD AND MATERIALS

Forty regions of interest (ROI) were extracted from digital mammography scans of 39 patients, and 39 ROIs were extracted from head and neck (HN) computed tomography (CT) scans of 39 patients. Mammography ROIs (256 x 256) contained normal breast parenchyma while each HN ROI (174 to 2819 total pixels) contained a manually delineated tumor. Two in-house software packages and two open-source packages (MaZda and IBEX) were used to calculate 6 first-order features (max, min, mean, standard deviation, skewness, kurtosis) and 4 gray-level co-occurrence matrix (GLCM) features (contrast, entropy, difference entropy, sum average) in each ROI. GLCM parameters (gray-level limits, binning, directionality) were modified to provide the greatest consistency across packages. The mean and standard deviation of each feature value across all ROIs were calculated. Non-parametric tests were used to compare feature pairs of corresponding features across software, and significance was determined using $p<0.001$ to correct for multiple comparisons.

RESULTS

For the mammography and HN cases, first-order features agreed to within 1.13±0.10% and 2.49±0.24%, respectively, except for kurtosis, which varied by 101±20% and 71.0±30.7%. Kurtosis was the only first-order feature to show statistically significant differences among the packages. The means of all second-order features differed significantly among all four packages by up to one order of magnitude and two orders of magnitude for the mammography and HN cases, respectively. Possible reasons for the increased differences in feature values for the HN cases include the reduced range in pixel values in the tumor and the non-rectangular ROIs, which warrant further investigation.

CONCLUSION

The large variation in calculated texture values among software packages as well as anatomic sites indicates that analysis should be customized to accommodate the imaging modality and clinical task of interest.

CLINICAL RELEVANCE/APPLICATION

Many research institutions have used open-source texture analysis software in a one-size-fits-all approach without considering the variations in the texture algorithms or their implementation.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at:

SSQ11-02 Quantifying Echogenicity of Solid Benign and Malignant Thyroid Nodules

Thursday, Nov. 30 10:40AM - 10:50AM Room: S403A

Awards
Student Travel Stipend Award

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PURPOSE

The Thyroid Imaging, Reporting and Data System (TIRADS) is designed to improve ultrasound characterization of thyroid nodules for effective clinical management of malignancy risk. The ACR TIRADS white paper identified six features for nodule categorization with diagnostic merit: composition, echogenicity, shape, size, margins, and echogenic foci. In this study, we present and validate method to quantify the echogenicity of solid nodules in order to predict malignancy risk.

METHOD AND MATERIALS

We evaluated 35 biopsy-proven malignant and 34 biopsy-proven benign solid thyroid nodules from thyroid ultrasound exams from 2013 to 2016. The nodules were segmented and the mean intensity of each nodule was calculated by averaging the mean intensities of representative sections in both the sagittal and transverse planes. The mean intensity of a sample of background thyroid parenchyma adjacent to each nodule was also obtained. A ratio was calculated between nodule intensity and adjacent thyroid parenchyma intensity. The resulting means were compared using a t test and the agreement between transverse and sagittal ratios was assessed with Bland Altman analysis.

RESULTS

The mean ratio of malignant nodule intensity to background thyroid intensity was 0.73. The mean ratio of benign nodule intensity to background thyroid intensity was 0.86. Two-tailed t-test demonstrated significance with a P value of 0.0015. Bland Altman demonstrated good agreement between sagittal and transverse ratios.

CONCLUSION

A ratio of thyroid nodule intensity to background thyroid parenchymal intensity is a useful predictor of malignancy in solid nodules, and calculating this ratio at the workstation may aid in accurate assessment of echogenicity.

CLINICAL RELEVANCE/APPLICATION

Quantification of solid thyroid nodule intensity at the workstation can help predict malignancy risk.

SSQ11-03 Diagnostic Accuracy of Radiomics-based Hepatic Venous Pressure Gradient for Clinically Significant Portal Hypertension

Thursday, Nov. 30 10:50AM - 11:00AM Room: S403A

Awards
Trainee Research Prize - Fellow

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PURPOSE

To investigate whether a radiomics-based hepatic venous pressure gradient (rHVPG) could be as accurate as the direct HVPG measurement in diagnosing clinically significant portal hypertension (CSPH).

METHOD AND MATERIALS

A training cohort of patients with portal hypertension (n = 71) was retrospectively recruited in 3 high-volume liver centers in China between August 2016 and March 2017. Computed tomography (CT) images were analyzed for radiomic features extraction. A LASSO regression model was used for data dimension reduction, feature selection, and radiomics signature building. Besides, a predictive model, which combined the radiomic signatures, liver volume and spleen volume, was developed using the two-class logistic regression analysis. To assess the diagnostic performance of rHVPG for CSPH with the invasive HVPG measurement as reference standard, receiver operating characteristic (ROC) curves were constructed. A validation was conducted on another cohort consisting of 12 patients with portal hypertension.

RESULTS

A total number of 10324 imaging features were extracted [Figure 1A, 1B]. A radiomics signature that consisted of 34 selected features, was highly correlated to the presence of CSPH (P < 0.001 for both training and validation cohorts). The predictive model containing variables of radiomics signature, liver volume and spleen volume [Figure 1C], demonstrated high accuracy with an area under ROC curve (AUC) of 1.000 (1.000-1.000). Additionally, the model provided an excellent prediction in the validation cohort with an AUC of 0.778 (0.512-1.000).

SSQ11-04 Investigation of Arterial Enhancement Fraction (AEF) In Functional Imaging of Hepatocellular Carcinoma (HCC) and Its Correlation with Alpha-Fetoprotein (AFP)

Thursday, Nov. 30 11:00AM - 11:10AM Room: S403A

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PURPOSE

To investigate the correlations between AEF and AFP and to discuss the clinical application value of AEF in the functional imaging of HCC.

METHOD AND MATERIALS

IRB approval was secured for this prospective study with informed consent obtained. 25 patients with pathologically proved HCC who underwent tri-phasic contrast-enhanced CT exam between May 2015 and September 2016 were enrolled(21 males and 4 females, 46y~68y), and divided into "Positive" (P) and "Negative" (N)group based on AFP levels (P group: AFP>200ng/ml). All scans were performed on a 128 row multi-detector CT (iCT 256, Philips) with following parameters: tube voltage 100kVp, automatic tube current modulation, pitch 0.993, rotation time 0.5s, collimation 128×0.635, FOV 350×350mm, slice thickness 3mm. Tri-phasic enhanced CT was acquired with 1.2ml/kg body weight of Iodixanol (Visipague 270, GE Healthcare, Ireland) injection at a rate of 4.5ml/s, followed by 20ml saline flush. On the basic of unenhanced, arterial, portal venous and delay phases of CT images, AEF color map was obtained with CT-Kinetics software (GE Healthcare), the corresponding texture features were automatically generated after the regions of interest (ROIs) defined by two 11-year experienced radiologists. Mann Whitney U test and boxplot were used to compare the difference between P and N group. Spearman correlation test and linear regression were applied to evaluate the correlation between texture features with AFP.

RESULTS

Significant differences(P<0.05) were found between two groups in several parameters, including StdDeviation, Variance, Uniformity, Inertia, Cluster Prominence and Haralick Correlation with 0.080 vs 0.147, 0.007 vs 0.023, 0.855 vs 0.750, 3.715 vs 8.373, 3.808 vs 21.530, and 56.210 vs 122.500 in N and P group, respectively. While mean value of AEF showed no statistical difference(P=0.22). All above parameters had significant correlations with AFP (stdDeviance was taken for an example shown in Figure 1).

CONCLUSION

AEF texture features reflected the distribution of HCC's blood supply, which had strong correlation with AFP level, and would be regarded as an option to predict the biological activity of HCC.

CLINICAL RELEVANCE/APPLICATION

AEF texture analysis method which combined morphological with functional imaging without additional invasive procedure or radiation exposure, could promisingly reflect pathological AFP level and provide more scientific basis efficiently for clinicians.

SSQ11-05 A Size-independent Radiomics Model for Classification of Indeterminate Pulmonary Nodules Seen at CT

Thursday, Nov. 30 11:10AM - 11:20AM Room: S403A

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PURPOSE

While radiomic signatures to classify lung nodules as malignant or benign exist, an effective classifier that is independent of size features has not been established. We hypothesized that we could derive a parsimonious set of radiomic features useful for classification independent of nodule size.

METHOD AND MATERIALS

96 Nodules (33 benign; 63 malignant) in CT scans of patients (70 M; 26 F; mean age = 67, range = 47-85) from our institution were considered for this study. Inclusion criteria were: confirmed tissue diagnosis and nodule size of 4-30 mm. Patients with screen-detected nodules, ground glass opacities, metastatic lung nodules, contrast-enhanced scans or scans with slice thickness > 3 mm were excluded. Segmentations were created in the Definiens Developer XD™ environment, followed by generation of 222 radiomic features per nodule characterizing tumor size, shape, location, intensity and texture. We built two linear classifiers, one using the full set of radiomic features, and one excluding 13 size-related features, using a sparse linear regression technique (LASSO) and cross-validation.

RESULTS

Mean nodule size was 18 mm (interquartile range [IQR] 11-23 mm), 22 mm (IQR 17-26 mm) and 14 mm (IQR 9-15 mm) for all 96, with 63 malignant, and 33 benign nodules, respectively. Upper lobe nodules constituted 29% and 6% of malignant and benign nodules respectively. 19% of malignant nodules had a spiculated margin compared to 9% of benign nodules. For both models developed, two texture features were most frequently selected by LASSO, indicating the importance of nodule texture as a predictor. The size-independent classifier had an Area Under the ROC Curve (AUC) of 0.812 (Confidence Interval (CI)=0.73-0.91), while including size features added only a modest improvement (AUC: 0.838 (CI=0.755-0.92)). In contrast, a clinical risk calculator consisting of age, smoking status, nodule size and location gave inferior performance (AUC: 0.524 (CI=0.4-0.65)).

CONCLUSION

Texture features were most informative for differentiating between benign and malignant pulmonary nodules, independent of clinical information and size-based features.

CLINICAL RELEVANCE/APPLICATION

Size-independent radiomic-based models have the potential to separate benign from malignant nodules when nodule sizes are similar.

SSQ11-06 Comparison of RECIST 1.1, irRC, irRECIST and WHO Criteria in Patients with Renal Cell Cancer Receiving Immune Therapy

Thursday, Nov. 30 11:20AM - 11:30AM Room: S403A

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PURPOSE

While tumor response assessment by WHO and RECIST 1.1 have been broadly used to predict the outcome of patients under conventional chemotherapy, alternative criteria such as irRC and irRECIST have been designed to consider the specific response patterns of certain tumor entities treated with immunotherapy such as pseudo-progression and tumor flare. Therefore, this study aims to determine the difference between these criteria in a selected cohort of 32 patients with renal cell cancer treated with immunotherapy.

METHOD AND MATERIALS

MINT Lesion software (Mint Medical GmbH, Dossenheim, Germany) was used to assess tumor response in all cases. A total of 141 image studies were evaluated using the 4 response criteria. The software produced an assessment of Complete Response (CR), Partial Response (PR), Stable Disease (SD)/No Change (NC) or Progressive Disease (PD) for each image study. Cohen's unweighted kappa statistic was used to evaluate agreement between criteria assessments.

RESULTS

Comparison of irRC and WHO (kappa=0.6948, 95% CI: 0.5999-0.7897) showed substantial agreement and comparison of RECIST 1.1 and irRECIST criteria showed almost perfect agreement (kappa=0.8917, 95% CI: 0.8303-0.9531). In 20 cases irRC produced an assessment of SD when WHO produced an assessment of PD. In 11 cases irRC produced an assessment of PR when WHO produced an assessment of PD. Additionally, there were 5 cases where irRECIST produced an assessment of SD when RECIST 1.1 produced PD and 6 cases where irRECIST produced PR when RECIST 1.1 produced PD. Application of irRECIST produced the least number of cases assessed as PD (n=32), followed by RECIST and irRC (n=43) and WHO (n=74).

CONCLUSION

This study found variation between all criteria, especially regarding assessment of progressive disease. irRECIST led to the fewest assessments of PD, likely because these criteria best consider the phenomenon of tumor flare and pseudo-progression that has been observed under immunotherapy. Further studies are needed to confirm if irRECIST also best predicts clinical outcome.

CLINICAL RELEVANCE/APPLICATION

Since our study has shown that irRECIST criteria best consider pseudo-progression and flare of RCC under immunotherapy, they may be best suited to follow these patients.

SSQ11-07 Radiomics of Multi-parametric MRI for Pre-treatment Prediction of Progression-Free Survival in Advanced Nasopharyngeal Carcinoma

Thursday, Nov. 30 11:30AM - 11:40AM Room: S403A

Participants
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PURPOSE

This study aimed to identify MRI-based radiomics for the pre-treatment prediction of progression-free survival (PFS) in patients with advanced nasopharyngeal carcinoma (NPC) (stage III-IVb) .

METHOD AND MATERIALS

One-hundred and eighteen patients (training cohort: n = 88; validation cohort: n = 30) with advanced NPC were enrolled. A total of 970 radiomics features were extracted from T2-weighted (T2-w) and contrast-enhanced T1-weighted (CET1-w) MRI. Least absolute shrinkage and selection operator (LASSO) regression was applied to select features for progression-free survival (PFS) nomograms. Nomogram discrimination and calibration were evaluated. Associations between radiomics features and clinical data were investigated using heat maps.

RESULTS

Eight MRI-based radiomics signature that significantly associated with PFS was identified from 970 features. The prognostic value of radiomics signature derived from joint CET1-w and T2-w images performed better than that from CET1-w or T2-w images alone. The TNM staging system yielded a C-index of 0.514 (95%CI: 0.432 to 0.596).The radiomics nomogram integrated radiomics signature from joint CET1-w and T2-w images with the TNM staging system showed a significant improvement of the TNM staging system in predicting PFS in the training cohort (C-index, 0.761 vs 0.514; $p < 2.68 \times 10\text{-}9$). The clinical nomogram yielded a C-index of 0.649 (95%CI: 0.552 to 0.746). The radiomics nomogram integrated radiomics signature with clinical data outperformed the clinical nomogram (C-index, 0.776 vs 0.649; $p < 1.60 \times 10\text{-}7$). The calibration curves showed the good agreements between nomogram-predicted and actual survival. These results were further confirmed in the validation cohort. Radiomics heatmaps suggested associations between radiomics features with tumor stages.

CONCLUSION

Multiparametric MRI-based radiomics nomogram shows more accurate than the traditional TNM staging system and clinical nomogram in predicting individualized PFS in advanced NPC, which epitomizes the pursuit of precision medicine and may affect patient treatment strategy.

CLINICAL RELEVANCE/APPLICATION

This present study developed and validated multi-parametric MRI- based radiomics as a convenient approach to predict individual PFS pre-treatment in patients with advanced NPC.

SSQ11-08 Radiophenomics: A Machine Learning Approach to Radiological Exploration of Atherosclerosis

Thursday, Nov. 30 11:40AM - 11:50AM Room: S403A

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CONCLUSION

Radiophenomics results in a promising unsupervised stratification of atherosclerotic cardiovascular burden, with the promise of addressing the heterogeneity and the progression of the disease.

Background

Atherosclerosis is a complex, heterogeneous and multi-district disease, whose progression can be conveniently assessed by a plethora of radiological measurements. Aim of this work is the integration of a group of radiological measurements, in order to single out some meaningful phenotypes and explore the disease.

Evaluation

The considered sample was constituted by 1283 subjects from the asymptomatic general population of a screening study (age:

60.7 +/- 8.3 years; males=46%). For each subject, who underwent an MSCT examination, mitral and aortic valve volumetric calcium, cornary volumetric calcium, Agatston calcium score, left and right carotid intima thickness, number of carorid plaques, pulmonary trunk diameter and pulmonary artery diameter were computed. The lipidic profiles were also assessed by measuring total cholesterol, LDL and HDL cholesterol, triglycerides; age, gender and BMI were also reported. On the basis of the 9 considered radiological measurements, the similarity between each couple of subjects was evaluated by the proximities obtained with an unsupervised random forest approach. Successively, a multidimensional scaling procedure was used to map each subject on a plane. Finally, a fuzzy c-means algorithm was used to identify the clusters of subjects in the similarity map (optional figure); to identify the correct number of clusters, the Xie-Beni index was computed.

Discussion

Three distinct phenotipes were singled out: A (n=219), B (n=845), C (n=219). Passing from phenotype A to B and C: Agatson score, pulmonary diameters, intima thickness and number of plaques of carotid arteries significantly increased. Contemporaneously, HDC cholesterol significantly decreased, while age, percentage of male gender and triglycerides increased; moreover, phenotypes B and C showed a BMI value significantly greater than A.

SSQ11-09 Nodule Interface Sharpness Radiomics Distinguishes Benign From Malignant Nodules on Non-Contrast CT Scans

Thursday, Nov. 30 11:50AM - 12:00PM Room: S403A

Participants
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PURPOSE

Many people with benign lung nodules are subjected to unnecessary surgical procedures due to the inability in making confident diagnostic predictions regarding nodule pathology on routine non-contrast CT scans. Interestingly, many malignant nodules are associated with lymphocytic infiltration which may manifest in the perinodular space and hence result in a differential textural appearance between the interior to exterior of the nodule. The aim of this study is to evaluate the role of Nodule Interface Sharpness (NiS), a new radiomic feature that aims to capture the textural transition going from the inside to the outside of the nodule.

METHOD AND MATERIALS

Our study comprised of CT scans of 290 patients from multiple institutions, one cohort for training (N=145) and the other (N=145) for independent validation. All patients had previously undergone surgical wedge resection for a suspicious nodule. A set of 48 NiS features from the nodules margins on 2D slices were extracted. The features pertain to the spiculations and intensity transitions along the nodule interface going from the inside to the outside of the nodule. A Support Vector Machine (SVM) based classifier was trained to distinguish benign from malignant nodules using the most informative NiS features identified on the training set via the Minimum Redundancy, Maximum Relevance (mRMR) feature selection algorithm. The model then applied to predicting presence of malignancies on the validation set.

RESULTS

The most informative NiS features identified were mean gray profile and entropy of the gradient magnitude of the voxels along the margin. The SVM classifier yielded an AUC=0.83 on the independent validation set. In comparison, two human readers with 13 and 3 years of experience had AUC's of 0.69 and 0.73.

CONCLUSION

Our results appear to suggest that the NiS radiomic features associated with lung nodules interface on non-contrast CT scans capture the transitional intensity profiles from the intra- to the peri-nodular space and are thus able to distinguish between benign and malignant nodules on CT scans.

CLINICAL RELEVANCE/APPLICATION

The combination of radiomic features based off NiS with human interpretations could allow for improved discrimination of benign from malignancy nodules and could help reduce unnecessary surgical interventions for pathologic confirmation of nodule diagnosis and also reduce the number and frequency of follow on CT scans for indeterminate findings.

SSQ12

Molecular Imaging (Theranostics)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S505AB

CT MR MI NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Gabriel C. Fine, MD, Seattle, WA (*Moderator*) Nothing to Disclose
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Sub-Events

SSQ12-01 HIF-Prolyl Hydroxylase 2 Silencing Using siRNA Delivered by MRI-Visible Nanoparticles Improves Therapy Efficacy of EPCs for Ischemic Stroke

Thursday, Nov. 30 10:30AM - 10:40AM Room: S505AB

Awards
Trainee Research Prize - Medical Student

Participants
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PURPOSE

Stroke is a leading cause of death and disability worldwide. Stem cell therapy has brought substantial benefits to patients as an important restorative therapeutics. However, its efficacy was limited by poor migration and survival ability. In this study, we aimed to enhance therapy efficacy of EPCs for ischemic stroke via PHD2 silencing using siRNA delivered by MRI visible nanoparticles.

METHOD AND MATERIALS

Human umbilical cord blood derived EPCs was transfected with siRNA targeting PHD2 delivered by MRI visible nanoparticles. Expression of CXCR4 and HIF-1a was detected by western blot 48h after siRNA transfection. In vitro transwell assay and H2O2 apoptosis assay was used to detect the migration and survival ability of EPCs respectively. 5×10^5 EPCs with or without PHD2 silencing (siPHD2-EPCs, siCON-EPCs) were transplanted intracardically 1 day after photothrombotic model of stroke was induced in nude mice. Functional recovery was assessed with mNSS and foot-faults test at 1 day before ischemic stroke induction and 1, 3, 7, 14 days after EPCs implantation. MRI and Bioluminescent imaging (BLI) were carried out at 1, 3, 7 days after EPCs transplantation. Prussian blue and GFP staining were carried out at 1 day and 7 day after EPCs transplantation. Angiogenesis, neurogenesis and white matter recovery were assessed at 7 days and 14 days respectively.

RESULTS

PHD2 silencing increased expression of CXCR4 and HIF-1a of EPCs. Both in vivo and in vitro results suggested that PHD2 silencing increased migration and survival ability of EPCs. Mice treated with siPHD2-EPCs showed significantly decreased infarct volume and increased fractional anisotropy (FA) in the ipsilesional corpus callosum than the other groups. Improved functional recovery was observed in the siPHD2-EPCs treated mice. At 7 days, increased BDFN expression was observed in the siPHD2-EPCs treated group. Histological analysis showed that angiogenesis, neurogenesis and white matter recovery were increased after siPHD2-EPCs treated than the other groups.

CONCLUSION

PHD2 silencing increased therapy efficacy of EPCs for ischemic stroke due to increased migration and survival ability.

CLINICAL RELEVANCE/APPLICATION

Our study provides an effective solution for the limitations of clinical stem cell therapy for ischemic stroke.

SSQ12-02 Tracking Stem Cell Transplants in Femoral Osteonecrosis of Pediatric Patients

Thursday, Nov. 30 10:40AM - 10:50AM Room: S505AB

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PURPOSE

To monitor stem cell transplants in osteonecrotic lesions of pediatric cancer survivors with ferumoxytol-enhanced MRI and correlate T2* signal kinetics with outcomes.

METHOD AND MATERIALS

In an ongoing prospective clinical trial (NCT02893293), we performed serial MR imaging studies of seven hip joints of six cancer survivors before and after decompression surgery for osteonecrosis (ON) treatment. We injected ferumoxytol prior to the surgery to label mesenchymal stem cells (MSC) in the bone marrow before their transplantation into osteonecrotic bone. We hypothesized that MR tracking of stem cells in the osteonecrotic bone would enable differentiation of successful and failed cell therapies. We compared T2* values of cell transplants with presence or absence of joint collapse at 12 months using a Student t-test.

RESULTS

Pre-surgical MRI scans of the patients' hip joints confirmed an osteonecrosis (ON) in the epiphysis of the femur, with an intact joint surface (eligibility criteria for the decompression procedure). Ferumoxytol administration lead to hypointense bone marrow enhancement on pre-surgical T2-FSE sequences. Following decompression surgery and transplantation of iron labeled MSC from the iliac crest into the ON, iron-labeled cells could be seen in the access canal. Five ON remained stable over 12 months after decompression surgery. Two ON showed a decreasing volume over time, ultimately collapsed and required artificial joint replacement. At 1-3 weeks after decompression surgery, T2* values of cell transplants in stable ON (2.797 ± 0.07) were significantly shorter ($p<0.05$) compared to T2* values of cell transplants in ON that ultimately collapsed (3.498 ± 0.2383).

CONCLUSION

Stem cell transplants in pediatric cancer survivors can be monitored with ferumoxytol-enhanced MRI. T2* signal kinetics of MSC in osteonecrotic lesions predict clinical outcomes. This immediately clinically applicable stem cell imaging test could become a powerful tool to diagnose success or failure of stem cell transplants in osteonecrotic bone in pediatric patients, monitor engraftment non-invasively and predict bone repair outcomes.

CLINICAL RELEVANCE/APPLICATION

This is the first study that shows the feasibility of tracking in vivo labeled stem cells in patients. The rapid disappearance of the cell transplant, as indicated by the iron signal on MR images, correlates with unfavorable clinical outcomes.

SSQ12-03 Integrin-Targeted Quantitative Multispectral Optoacoustic Tomography with MRI Correlation for Monitoring a BRAF/MEK Inhibitor Combination Therapy in Experimental Human Melanoma Xenografts in Mice

Thursday, Nov. 30 10:50AM - 11:00AM Room: S505AB

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PURPOSE

To investigate a multimodal imaging protocol of avß3-integrin-targeted multispectral optoacoustic tomography (MSOT) and MRI for monitoring a BRAF/MEK inhibitor combination therapy in a murine model of human melanoma.

METHOD AND MATERIALS

Human BRAF V600E-positive melanoma xenografts (A375) were implanted subcutaneously in the lateral flank of n=10 balb/c nude mice. Imaging was performed before (day 0) and after (day 7) a BRAF/MEK inhibitor combination therapy (encorafenib, 0.03 mg/d; binimetinib, 0.012 mg/d, Array BioPharma Inc., therapy n=5) or placebo treatment (control n=5), respectively. MSOT was conducted on a preclinical system (inVision 256-TF, iThera Medical GmbH) unenhanced and 5 h after i.v. injection of a avß3-integrin-targeted fluorescent probe (IntegriSense 750, Perkin Elmer, 4 nmol). For tumor volume assessments, T2w MRI data sets were subsequently acquired on a clinical 3 Tesla scanner (Magnetom Skyra, Siemens Healthineers). MSOT data acquired at multiple wavelengths was spectrally unmixed to derive the avß3-integrin-specific signal. Imaging results were validated by ex vivo immunohistochemistry with regard to microvascular density (CD31).

RESULTS

A significant decrease of avß3-integrin specific tumor signal was observed in the therapy group (-79 %, from 7.98±2.22 to 1.67±1.30, p=0.030), whereas no significant change was detected in the control group (-55 %, from 6.60±6.51 to 3.69±1.93, p=0.348). Immunohistochemistry demonstrated a significant decrease in microvascular density under therapy (CD31; therapy: 119±15, control: 312±62, p=0.008). Tumor volumes increased in both groups with no significant intergroup difference (therapy: +107±42 mm3; control +112±44mm3, p>0.05). Competitive in vivo blocking studies using avß3-integrin receptor antagonist cilengitide (Selleck Chemicals) confirmed the selective binding of the targeted fluorescent probe.

CONCLUSION

Quantitative MSOT allowed for the early non-invasive monitoring of a BRAF/MEK inhibitor combination therapy in BRAF V600E-

positive human melanoma xenografts in mice, adding molecular information on tumor avß3-integrin receptor status to morphology-based tumor response assessments.

CLINICAL RELEVANCE/APPLICATION

Quantitative MSOT with targeted probes may generate additional clinical imaging biomarkers of early tumor response in human melanoma under novel targeted treatment regimens.

SSQ12-04 Why Iron Oxide Labeling Matters for Stem Cell Mediated Cartilage Repair: Insights from a Large Animal Model

Thursday, Nov. 30 11:00AM - 11:10AM Room: S505AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The success or failure of matrix associated stem cell implants (MASI) in cartilage defects is evaluated on MR images at 6-12 months after MASI, based on the degree of cartilage repair. We evaluated if iron oxide nanoparticle labeling could accelerate this diagnosis based on different iron signal kinetics of successful and failed implants.

METHOD AND MATERIALS

Studies were performed in seven Göttingen minipigs with artificially created cartilage defects of the distal femur. We aspirated and isolated mesenchymal stromal cells from the iliac crest and labeled the cells with ferumoxytol (Feraheme), using a clinically translatable, transfection agent-free protocol. We implanted viable and apoptotic ferumoxytol-labeled MSCs into 22 cartilage defects and monitored the signal of the implants with a clinical 3T MRI scanner at week 1, 2, 4, 8, 12 and 24, using a proton density sequence (3700/34/90 TR/TE/alpha) and a multiecho spin echo sequence (3500/45 TR/TE). Implants without ferumoxytol label served as controls. Quantitative T2 relaxation times were compared for significant differences between labeled and unlabeled as well as viable and apoptotic MASI using Student t-tests.

RESULTS

Iron oxide labeled MASI showed significant T2 shortening compared to adjacent normal cartilage and unlabeled implants. At week 1, viable and apoptotic MASI did not show significant differences in T2 relaxation times (20.91±2.12 ms versus 20.97±2.07 ms). At week 2, T2 relaxation times of viable ferumoxytol-labeled implants (21.79±2.59) ms were significantly lower compared to apoptotic ferumoxytol-labeled implants (27.93±3.49 ms, $p<0.05$). The label disappeared in both groups at 4 weeks. Histological correlation at 24 weeks showed complete defect repair of viable MASI and incomplete defect repair of apoptotic MASI.

CONCLUSION

Rapid loss of iron signal early after MASI indicates cell death and predicts incomplete defect repair many weeks later. To our knowledge, this is the first study to detect early engraftment failure of MASI with MRI in a large animal model.

CLINICAL RELEVANCE/APPLICATION

MRI of ferumoxytol-labeled MASI represents an easily clinically translatable method for detection of early engraftment failure in arthritic joints.

SSQ12-05 A Case Series of NSCLC Patients Performing both C-11 Erlotinib and F-18 FDG PET/CT Comparing with EGFR Mutation Status

Thursday, Nov. 30 11:10AM - 11:20AM Room: S505AB

Participants
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PURPOSE

To evaluate the ability of C-11 erlotinib PET/CT as a non-invasive approach to identify EGFR mutation status and to study various PET parameters that may serve as a potential proxy for selecting the patient who could benefit from erlotinib treatment.

METHOD AND MATERIALS

We performed PET/CT in 5 NSCLC patients, each with both C-11 erlotinib and F-18 FDG. All had EGFR mutation status of the

tumors. There were two patients who had wild-type EGFR and three patients who had EGFR mutation i.e., exon 21 mutation (L858R), exon 19 insertion and exon 19 deletion. Three experienced nuclear medicine physicians, unknown of the patients' EGFR status, read the C-11 erlotinib PET/CT by visual analysis and gave the result as positive or negative. PET parameters i.e., SUVmax, SUVavg, MTV, TLG, Tumor to background ratio were analysis in both C-11 erlotinib and FDG studies.

RESULTS

There was a wide range of C-11 erlotinib uptake in primary tumor and metastatic sites. By visual analysis, 67% correction was observed (10/15). The average SUVmax and tumor to background mediastinal blood pool ratio were 2.04±0.68 vs 2.18±1.45 (p = 0.77) and 3.44±1.63 vs 1.56±1.10 (p = 0.02) in EGFR mutation positive vs EGFR mutation negative, respectively. Sub-group analysis of SUV parameters in primary tumor, lymph node and distant metastases including adrenal, bone, brain and muscle showed no significant difference between each group. There was no significant correlation between FDG parameters (SUVmax, SUVavg, MTV, TLG) and C-11 erlotinib parameters as well as EGFR mutation status.

CONCLUSION

Our study confirmed the tumor heterogeneity of C-11 erlotinib binding in primary tumor and each metastatic sites. The tumor to mediastinal blood pool ratio of C-11 erlotinib uptake was the only parameter that seems to be significantly different between EGFR mutation positive vs negative group.

CLINICAL RELEVANCE/APPLICATION

C-11 erlotinin PET/CT confirmed the tumor heterogeniety of erlotib binding in primary NSCLC and metastastic sites in the same patient as well as different patients with different EGFR mutation status.

SSQ12-06 MR Molecular Imaging and Tumor Theranostic 2D Ultrathin MnO2 Nanosheets with Fast Responsibility to Endogenous Tumor Microenvironment and Exogenous NIR Irradiation

Thursday, Nov. 30 11:20AM - 11:30AM Room: S505AB

Participants
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PURPOSE

To study the feasibility of using two-dimensional (2D) ultrathin MnO2 nanosheets with ultra-sensitivity to tumor microenvironment (TME) to enhance MR molecular imaging and photothermal therapy (PTT).

METHOD AND MATERIALS

The fabrication of ultrathin 2D MnO2 nanosheets were based on an exfoliation strategy. The surface of MnO2 nanosheets were modified by Soybean phospholipid (SP) to enhance stability in physiological environments without significant toxicity. The MnO2 nanosheets and MnO2-SPs were characterized by various methods. The murine breast cancer cell line (4T1) and Kunming mice were cultured to evaluate *in vitro* cell and *in vivo* biological toxicity. Importantly, we investigated *in vitro* and *in vivo* MR imaging evaluations and photothermal therapy on mice breast tumor xenografted tumor model.

RESULTS

These ultrathin 2D MnO2 nanosheets show the intriguing characteristic of disintegration and releasing of Mn2+ in response to the mild acidic and elevated reducing conditions of TME, which has successfully realized the pH- and reducing-responsive T1-weighted magnetic resonance imaging of tumor without obvious biological toxicity. *In vivo* MRI, it has been found that the positive T1-weighted MRI signal increased significantly after the intravenous administration of MnO2-SPs nanosheets into mice bearing the breast 4T1 cancer xenograft. Furthermore, the high PTT efficiency of 2D MnO2 nanosheets responsive to exogenous NIR irradiation have been systematically demonstrated both *in vitro* and *in vivo* for suppressing the tumor growth.

CONCLUSION

For the first time, we have successfully demonstrated that the exfoliated ultrathin 2D MnO2 nanosheets feature the high intrinsic photothermal-conversion capability for PTT against tumor, which are also the first paradigm of inorganic photothermal agents with the ultra-sensitivity to the endogenous TME, including mild acidic and reducing conditions. This tumor sensitivity could not only realize the pH- and reducing-responsive T1-weighted MR imaging, but also possibly facilitate the metabolism and excretion of the MnO2 nanosheets after the tumor theranostics.

CLINICAL RELEVANCE/APPLICATION

2D MnO2 nanosheets can serve as powerful MR imaging-guided photothermal agents for excellent tumor ablation.

SSQ12-07 Non-Invasive Imaging of Transplanted Therapeutic Cells in the Inflamed Rat Brain by Spectral Photon Counting Computed Tomography (SPCCT)

Thursday, Nov. 30 11:30AM - 11:40AM Room: S505AB

Participants
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PURPOSE

Cell therapy holds promise for treatment of ischemic stroke in the chronic phase. To foster translation into the clinic, there is a need for non-invasive techniques that enable long-term follow-up of cell fate. Our purpose is to provide proof of concept of specific and quantitative in vivo imaging of therapeutic cells by an innovative, translational technique: K-edge imaging by spectral photon counting computed tomography (SPCCT).

METHOD AND MATERIALS

M2-polarized anti-inflammatory macrophages were labelled with gold nanoparticles (AuNPs, 0.1 mg/mL, 15 h) and gold/cell quantified by mass spectroscopy. Rats underwent intracerebral (IC) injection of lipopolysaccharide to induce chronic neuroinflammation. Two weeks after, the same rats were scanned in vivo using a pre-clinical SPCCT prototype after IC delivery of 5x105 AuNPs-labelled or control unlabeled cells. A phantom with a concentration range of AuNPs (0 to 8 mg/mL) was scanned for calibration of in vivo quantification. Anode tube voltage of 120 kVp and current of 100 mA were used. The same phantom and rats (ex-vivo) were then scanned by µCT and K-edge imaging by synchrotron X-rays (SXR) as gold standards for validation. Gold K-edge images were reconstructed and gold signal was manually delineated for quantification.

RESULTS

K-edge imaging of gold with SPCCT detected gold-labelled cells within the brain, in agreement with µCT and SXR. Mass spectroscopy detected an amount of 165 gold pg/cell, corresponding to 82.5 µg of gold injected within cells. The measured concentrations in phantom linearly correlated with the known concentrations (R2 = 0.99, slope: 0.82, intercept: 0.19), supporting the potential for accurate in vivo gold-cell quantification, which is currently in progress.

CONCLUSION

Our initial results provide proof-of-concept for non-invasive in vivo imaging of AuNPs-labelled therapeutic cells by SPCCT, which has the advantage of being specific and quantitative.

CLINICAL RELEVANCE/APPLICATION

SPCCT may be valuable to improve cell therapy in chronic stroke patients.

SSQ12-08 PET/CT Imaging of the Alkylphosphocholine Analog 124I-CLR1404 in High and Low-Grade Brain Tumors

Thursday, Nov. 30 11:40AM - 11:50AM Room: S505AB

Participants
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PURPOSE

CLR1404 is a cancer-selective alkyl phosphocholine (APC) analog that can be radiolabeled with 124I for PET imaging, 131I for targeted radiotherapy and/or SPECT imaging, or 125I for targeted radiotherapy. Studies have demonstrated avid CLR1404 uptake and prolonged retention in a broad spectrum of preclinical tumor models. The purpose of this pilot trial was to demonstrate avidity of 124I-CLR1404 in human brain tumors and develop a framework to evaluate this uptake for use in larger studies.

METHOD AND MATERIALS

12 patients (8 men and 4 women; mean age of 43.9 ± 15.1 y; range 23 - 66 y) with 13 tumors were enrolled. Eleven patients had suspected tumor recurrence and 1 patient had a new diagnosis of high grade tumor. Patients were injected with 185 MBq ± 10% of 124I-CLR1404 followed by PET/CT imaging at 6-, 24-, and 48-hours. 124I-CLR1404 PET uptake was assessed qualitatively and compared with MRI. After PET image segmentation SUV values and tumor to background ratios were calculated.

RESULTS

There was no significant uptake of 124I-CLR1404 in normal brain. In tumors, uptake tended to increase to 48 hours. Positive uptake was detected in 9 of 13 lesions: 5/5 high grade tumors, 1/2 low grade tumors, 1/1 meningioma, and 2/4 patients with treatment related changes. 124I-CLR1404 uptake was not detected in 1/2 low grade tumors, 2/4 lesions from treatment related changes, and 1/1 indeterminate lesion. For 6 malignant tumors, the average tumor to background ratios (TBR) were 9.32 ± 4.33 (range 3.46 to

15.42) at 24 hours and 10.04 ± 3.15 (range 5.17 to 13.17) at 48 hours. For 2 lesions from treatment related change, the average TBR were 5.05 ± 0.4 (range 4.76 to 5.33) at 24 hours and 4.88 ± 1.19 (range 4.04 to 5.72) at 48 hours. PET uptake had areas of both concordance and discordance compared with MRI.

CONCLUSION

124I-CLR1404 PET demonstrated avid tumor uptake in a variety of brain tumors with high tumor-to-background ratios. There were regions of concordance and discordance compared with MRI, which has potential clinical relevance. Expansion of these studies is required to delineate the clinical significance of these PET findings.

CLINICAL RELEVANCE/APPLICATION

124-CLR1404 PET provides unique molecular imaging properties in brain tumors and may add complementary diagnostic information to MRI and thus has potential to improve diagnostic certainty.

SSQ12-09 Early Stage Detection of Stem Cell Transplant Rejection with a Ferumoxytol-Based Dual-Modality Imaging Probe

Thursday, Nov. 30 11:50AM - 12:00PM Room: S505AB

Participants
Hossein Nejadnik, MD, PhD, Stanford, CA (*Presenter*) Nothing to Disclose
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Cody Wolterman, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Limited survival of transplanted stem cells represents a significant bottleneck for successful tissue regeneration. The goal of this study was to develop a novel dual-modality imaging probe, composed of a superparamagnetic nanoparticle backbone for cell detection and a fluorescent apoptosis marker.

METHOD AND MATERIALS

We immobilized caspase-3 cleavable peptides (KKKKDEVD-AFC) on the surface of the FDA approved nanoparticle compound ferumoxytol to prepare ferumoxytol-AFC nanoparticles (Feru-AFC NPs). Size distribution and Zeta potential of Feru-AFC NPs were measured by Dynamic Light Scattering (DLS). Mesenchymal stem cells (MSCs) were incubated with Feru-AFC NPs or ferumoxytol (control group) and underwent Prussian blue stains and ICP mass spectrometry as well as in vitro fluorescent and MR imaging. Then, intravital microscopy (IVM) was performed on matched (syngeneic) or mismatched (porcine-derived) MSCs, implanted in skull defects of six C57BL/6J mice. The mice underwent MR and fluorescent imaging on day 1, 3, 6, and 9. T2 relaxation time and fluorescent signal of the two groups were compared with a Student's t-test, using a $p<0.05$.

RESULTS

Feru-AFC NPs could be efficiently internalized into MSCs, as confirmed by Prussian blue stains and ICP mass spectrometry. Labeled MSC showed a significantly shorter T2-relaxation time compared to unlabeled MSCs ($p<0.05$). Feru-AFC NPs did not show significant fluorescence, however, in the presence of recombinant human caspase-3 or extract of apoptotic MSCs, Feru-AFC NPs showed significant green fluorescence due to cleavage of DEVD and release of AFC fluorophores. Accordingly, viable Feru-AFC NP-labeled MSCs showed no detectable fluorescence, while apoptotic Feru-AFC NP-labeled MSCs showed significant green fluorescence. In vivo, MR imaging enabled localization of cell transplants in skull defects. Mismatched MSC implants showed significantly higher fluorescent signal compared to matched MSC implants three days after implantation ($p<0.05$).

CONCLUSION

Feru-AFC NPs represent a novel tool for long-term stem cell tracking through MRI and early diagnosis of cell apoptosis through simultaneous fluorescence imaging.

CLINICAL RELEVANCE/APPLICATION

The described dual-modality contrast agent could improve monitoring of the localization and early diagnosis of cell rejection/apoptosis and direct patients with failed implants to repeated interventions.

SSQ13

Science Session with Keynote: Musculoskeletal (Metal Artifact Reduction Techniques)

Thursday, Nov. 30 10:30AM - 12:00PM Room: E451A

CT MK MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Kenneth A. Buckwalter, MD, Indianapolis, IN (*Moderator*) Research Grant, Siemens AG
Naveen Subhas, MD, Cleveland, OH (*Moderator*) Research Grant, Siemens AG

Sub-Events

SSQ13-01 Musculoskeletal Keynote Speaker: Update on Metal Artifact Reduction Techniques

Thursday, Nov. 30 10:30AM - 10:40AM Room: E451A

Participants
Christine B. Chung, MD, La Jolla, CA (*Presenter*) Nothing to Disclose

SSQ13-02 Quantitative Evaluation of Fracture Healing After Internal Fixation of Spinal Fractures by Dual-Energy Technology

Thursday, Nov. 30 10:40AM - 10:50AM Room: E451A

Participants
Qian Yang, Shanxi, China (*Presenter*) Nothing to Disclose
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Kai Sun, Shanxi, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Objective: To investigate the value of dual-energy technology in the treatment of fracture healing after internal fixation of spinal fractures.

METHOD AND MATERIALS

Methods: 60 cases of spine (cervical spine 5 cases, thoracic vertebrae 25 cases, lumbar vertebrae 30 cases) were collected and examined by dual-energy X-ray absorptiometry (DXA).The bone mineral density (BMD) measurements were performed at the same time by gemstone spectral imaging (GSI) scan for patients with spinal fractures, before operation, after metal internal fixation, and after removal of metal internal fixation. The data used in the analyzing were obtained by the energy spectrum analysis software. The single energy images at different energy levels of 40-140 keV, the base substance diagram of calcium and water were obtained. The ROIs were measured by different parameters among 40-140 keV (with interval 10 keV) and the CT values of different energy levels, the calcium and water based material density, and the bone density values were calculated.

RESULTS

Results: The best single energy image was obtained at 60 keV. Before operation, there was statistical significance ($P < 0.05$) between the bone mineral densities getting from GSI (0.440 ± 0.056 g / cm3) and QCT (0.404 ± 0.069 g / cm3) , and the former was greater than that of the QCT. The GSI measurement was (0.360 ± 0.026 g / cm3) in the 6 patients healing well,(0.281 ± 0.032g / cm3) in the 8 patients delayed healing, and (0.121 ± 0.021g / cm3) in the 8 patients nonunion.

CONCLUSION

Conclusion: The energy spectrum CT scanning technique can effectively remove metal artifacts and ray beam hardening artifacts, and clearly show the fine structure after metal fixation for fracture, and the image quality is higher. The best single energy image was achieved at the 60keV. By using of calcium-water-based substance pairs, the bone density could be measured more accurately than by QCT, and can be used as a new bone density measurement method to predict the degree of fracture healing.

CLINICAL RELEVANCE/APPLICATION

can be used as a new bone density measurement method to predict the degree of fracture healing.

SSQ13-03 The Value of a New Single Energy Metal Artifact Reduction (SEMAR) Algorithm in Post-Surgery Follow-Up of Patients with Knee Tumor Prostheses

Thursday, Nov. 30 10:50AM - 11:00AM Room: E451A

Participants
Lei Ding, Guangzhou, China (*Presenter*) Nothing to Disclose
Fang-Ling Zhang, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Ling Ma, MD, Canton, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the effect of a new single energy metal artifact reduction (SEMAR) algorithm with a 320 Multidetector computed tomography (MDCT) volume scanner in post-surgery follow-up of patients with knee tumor prostheses.

METHOD AND MATERIALS

From November 2015 to February 2017, 95 consecutive patients (59 males, 36 females; mean age, 24.2 years; age range, 9-64 years) with a tumor prosthesis of knee joint underwent a 320-MDCT scan. The images were reconstructed using two different methods: conventional iterative reconstruction (IR) alone and IR associated with SEMAR. Four radiologists visually graded the whole image quality at articular level on a 6-point scale from 0 (periprosthetic anatomic structures are completely obscured by metal artifacts) to 5 (periprosthetic structures are recognized with high confidence). Additionally, the readers assessed the presence of periprosthetic complication on a similar 6-point scale from 0 (extensive artifacts, prosthetic complications are unable to be recognized) to 5 (minimal artifacts, prosthetic complications are recognized with high confidence). Wilcoxon matched-pairs signed rank test and Intra-class correlation coefficients (ICCs) were used for the scores of image quality and prosthetic complications.

RESULTS

Visualization of periprosthetic structures were significantly improved by the SEMAR algorithm (3.8~4.3 vs. 1.2~1.6, $P<0.05$). In 66 of 95 patients, prosthetic complications were confirmed by other imaging examination, clinical or pathology. and prosthetic complications. The new algorithm also increased diagnostic confidence of prosthetic complications (4.3~4.7 vs 1.3~1.9, $P<0.05$). The sensitivity of diagnostic confidence of prosthetic complications was increased (98.5% vs. 45.5%, $P<0.05$).

CONCLUSION

The SEMAR visibly reduces the metal artifact and can increase diagnostic confidence of prosthetic complications in patients with knee tumor prostheses.

CLINICAL RELEVANCE/APPLICATION

The SEMAR can visibly reduces the metal artifact and increase diagnostic confidence of prosthetic complications in patients with knee tumor prostheses.

SSQ13-04 Cross-sectional Imaging of the Bone-Implant Interface of Total Ankle Arthroplasty Implants: CS-SEMAC MRI versus IMAR CT

Thursday, Nov. 30 11:00AM - 11:10AM Room: E451A

Participants
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Jan Fritz, MD, Baltimore, MD (*Presenter*) Research Grant, Siemens AG; Scientific Advisor, Siemens AG; Scientific Advisor, Alexion Pharmaceuticals, Inc; Speaker, Siemens AG

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PURPOSE

Imaging evaluation of the bone-implant interfaces of total ankle arthroplasty is helpful for the assessment of osseous implant integration; however, it is unclear which imaging modality performs best. Therefore, we evaluated the visibility of the bone-implant interface of total ankle arthroplasty implants by comparing two state-of-the-art metal artifact reduction MRI and CT techniques.

METHOD AND MATERIALS

After institutional review board approval, a total ankle arthroplasty system (TMTA, Titanium and Cobalt-Chromium alloy, Zimmer, Warsaw, Indiana) was implanted into 6 fresh frozen human cadaver ankles. Each specimen underwent cross-sectional imaging using Compressed Sensing (CS) SEMAC MRI at 1.5T and Iterative Metal Artifact Reduction (IMAR) CT at 120 keV. A total of 12 studies (6 CT, 6 MRI) were created, which consisted of axial, sagittal and coronal images with 3 mm slice thickness and similar slice orientations. The blinded and randomized data sets were subsequently independently analyzed by two experienced observers. After three months, both observers analyzed the data sets again. Using a four quadrant scheme, the visibility of the bone-implant

interface was evaluated on each slice orientation using equidistant 5-point Likert scales. Descriptive statistics, ICC, and Mann-Whitney U test were used for analysis. A p-value of <0.05 was considered significant.

RESULTS

The inter-observer agreement (kappa 0.815, 95%-CI 0.729-0.874) and intra-observer agreement (kappa intra-observer 1 0.904, 95% CI 0.859-0.934; kappa intra-observer 2 0.835, 95%-CI 0.758-0.887) were high with > 80% exact matching ratings for each image orientation, quadrant and imaging modality. The average 4-quadrant visibility score was 18 for CS-SEMAC MRI and 15 for IMAR CT ($p < 0.001$). Additionally, CS-SEMAC MRI consistently showed significantly higher scores for matched slice orientation and cadavers (axial: $p<0.001$, sagittal: $p<0.001$, coronal; $p<0.001$, cadaver 1: $p<0.001$, cadaver 2: $p=0.011$, cadaver 3: $p<0.001$, cadaver 4: $p=0.001$, cadaver 5: $p<0.001$, cadaver 6: $p<0.001$).

CONCLUSION

CS-SEMAC MRI is superior to IMAR CT for the visualization of the bone-implant interface of total ankle arthroplasty implants.

CLINICAL RELEVANCE/APPLICATION

CS-SEMAC metal artifact reduction MRI technique substantially improves the visibility of the host bone-implant interfaces of total ankle arthroplasty implants, suggesting a change of postoperative imaging from CT toward MRI.

SSQ13-05 Reduction of Metallic Artefacts from Spinal Fusions Using Virtual Monoenergetic Imaging by Dual Layer Spectral Computed Tomography

Thursday, Nov. 30 11:10AM - 11:20AM Room: E451A

Participants
Julia Dangelmaier, MD, Munich, Germany (*Presenter*) Nothing to Disclose
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Martin Renz, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Andreas Sauter, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Isabelle Riederer, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the clinical potential of virtual monoenergetic images generated with a dual-layer spectral Computed Tomography (CT) system and determine the optimal settings for reduction of metallic artefacts from posterior spinal fusions.

METHOD AND MATERIALS

Twenty patients with posterior spinal fusion who underwent a spectral CT scan (IQon Spectral CT, Philips Healthcare, USA) for various clinical indications were included in this study. Two independent readers evaluated axial 0.9 mm slides with soft tissue and bone window settings. Image quality of the conventional scan was compared with virtual monoenergetic images at 40, 60, 80, 100, 120, 140, 160, 180 and 200 keV. A four point Likert-scale was used to document subjective impression of overall and specific diagnostic image quality for either the implant inheriting bone, muscle, spinal canal or retroperitoneal vessels. The Hounsfield Units of the area with the most pronounced streak artefact as well as the Hounsfield Units of a reference area containing fat and muscle was documented for every keV-setting.

RESULTS

Quantitative analysis showed statistically significant artefact reduction for higher monoenenergetic levels compared to conventional images ($p<0.05$). Analogously, qualitative analysis revealed significant improvement of overall image quality ($p<0.05$) and benefit for all:tissues separately compared:to the original images in the range from 80 to 200 keV ($p<0,05$). Optimal overall keV-setting was 180 keV and ranged from 160 to 200 keV for the implant inheriting bone, the spinal canal, adjacent muscle and retroperitoneal vessels. Our results reveal high inter-reader agreement for qualitative evaluations (ICCs >0.927; $p<0.05$).

CONCLUSION

Dedicated keV-settings to evaluate either the implant inheriting bone, the spinal canal, adjacent muscle or retroperitoneal vessels - structures which are frequently of peculiar interest after posterior spinal fusions - are recommended.

CLINICAL RELEVANCE/APPLICATION

Virtual monoenergetic images of higher energies provide significant reduction of metallic artefacts from posterior spinal fusions.

SSQ13-06 SMART (Sequences for Metal Artifact Reduction around a Tumor Prosthesis) MRI: Diagnostic Performance for Detection of Recurrence and Complications around a Tumor Prosthesis

Thursday, Nov. 30 11:20AM - 11:30AM Room: E451A

Participants
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Adam Levin, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Carol Morris, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Jan Fritz, MD, Baltimore, MD (*Presenter*) Research Grant, Siemens AG; Scientific Advisor, Siemens AG; Scientific Advisor, Alexion Pharmaceuticals, Inc; Speaker, Siemens AG

PURPOSE

To assess the feasibility and performance of an MRI protocol including conventional and fast metal-reduction anatomic (T1/STIR, contrast-enhanced) and functional (dynamic contrast-enhanced (DCE)) imaging for the surveillance of patients who have undergone limb-salvage reconstruction with a tumor prosthesis.

METHOD AND MATERIALS

Following IRB approval and informed consent, 15 subjects with tumor prostheses, underwent 17 MRIs at 1.5T. MRI included two-plane anatomic imaging (T1-weighted/STIR, post-contrast T1-weighted, subtraction of pre-contrast from post-contrast) with both conventional WARP and fast compressed-sensing (CS)-SEMAC sequences, and functional imaging (DCE-MRI with 7-second resolution). One observer recorded the quality of each sequence (1=>75%, 2=25-75%, 3=10-25%, 4=no substantial-artifacts) adjacent to and remote from the prosthesis, and the presence of recurrence by three interpretation sessions (WARP, WARP+CS-SEMAC, WARP+CS-SEMAC+DCE) using a 5-point confidence scale (definitely-not, probably-not, possibly-present, probably-present, definitely-present). ROC analysis was performed, using histology as the reference for positive recurrence, and minimum 6-month stability for absence of recurrence.

RESULTS

Of 17 studies, there were 4 histologically-proven intramuscular recurrences. Average image quality was different adjacent to the prosthesis compared with remote from the prosthesis on T1, STIR and contrast-T1 sequences (WARP:1.2 vs 3.9, CS-SEMAC: 2.9 vs 3.4, respectively). ROC analysis revealed improved diagnostic performance for the detection of tumor recurrence with the successive addition of CS-SEMAC and DCE imaging to WARP (area-under-the-curve: WARP=0.84, +CS-SEMAC=0.92, +DCE=1.0).

CONCLUSION

An MRI protocol including conventional metal reduction (WARP), and fast CS-SEMAC and DCE-MRI offers good diagnostic performance for the detection of recurrence in patients with a history of limb salvage surgery and tumor prostheses.

CLINICAL RELEVANCE/APPLICATION

Following resection and reconstruction with a tumor prosthesis, cross-sectional imaging has traditionally been limited. With the advent of SMART-MRI, surveillance imaging of patients with tumors prostheses is now possible with high diagnostic accuracy.

SSQ13-07 Minimizing CT Radiation Dose in Total Hip Arthroplasty Patients Using Model-Based Iterative Reconstruction and Orthopedic Metal Artifact Reduction

Thursday, Nov. 30 11:30AM - 11:40AM Room: E451A

Participants
Ruud H. Wellenberg, MSc, Amsterdam, Netherlands (*Presenter*) Nothing to Disclose
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Geert J. Streekstra, PhD, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose
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Harmen B. Ettema, Zwolle, Netherlands (*Abstract Co-Author*) Nothing to Disclose
Martijn F. Boomsma, MD, Zwolle, New Caledonia (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To minimize CT radiation dose in patients with large metal-on-metal total hip prostheses using model-based iterative reconstruction (iMR) combined with orthopedic metal artifact reduction (O-MAR).

METHOD AND MATERIALS

Patients with a unilateral or bilateral metal-on-metal total hip prosthesis were included. Patients were scanned on a Philips iCT 256-slice CT scanner. Each patient received a conventional CT pelvis and a low-dose CT pelvis with respectively -20%, -43%, -60% or -80% lower CT radiation dose for patients in group 1, 2, 3 or 4 respectively. The conventional CT pelvis was reconstructed with iterative reconstruction, iDose4 level 4. The low-dose CT pelvis was reconstructed with iDose4 level 4 and model-based iterative reconstruction (iMR, levels 1, 2 and 3). All images were reconstructed with and without the use of O-MAR. CT numbers, noise or standard deviations (SDs) and contrast-to-noise-ratios (CNRs) were determined in muscle, fat, the bladder and background.

RESULTS

In this ongoing study, 23/80 patients were included for first analysis. In total 5, 6, 7 and 5 patients were included in group 1, 2, 3 and 4 respectively. Dose-length-products (DLPs) were reduced from 767.4 to 659.3 (-16%), 637.6 to 380.8 (-41%), 670.3 to 306.6 (-56%) and 840.1 to 199.6 (-77%) for group 1, 2, 3 and 4 respectively. While reducing radiation dose with 20%, 43%, 60% or 80%, CT numbers accuracy was maintained, SDs decreased ($p<0.01$) and CNRs ($p<0.001$) increased in iMR and O-MAR images compared to iDose4 and O-MAR images. In iMR level 1 and O-MAR images, CNRs between muscle and fat were on average 94%, 74%, 54% and 47% higher compared to iDose4 and O-MAR images while reducing radiation dose with 20%, 43%, 60% or 80%.

CONCLUSION

The use of iMR and O-MAR reduces standard deviations, increases CNRs and maintains CT number accuracy while reducing radiation dose in total hip arthroplasty patients up to 80% compared to iDose4 and O-MAR.

CLINICAL RELEVANCE/APPLICATION

Despite quantitative measurements show that the use of iMR enables a radiation dose reduction up to 80% compared to iDose4 in total hip arthroplasty patients, qualitative analysis is essential.

SSQ13-08 Evaluation of CT Metal Artifact Reduction Techniques in Patients with Total Shoulder Arthroplasties

Thursday, Nov. 30 11:40AM - 11:50AM Room: E451A

Awards

Student Travel Stipend Award

Participants
Scott M. Boeke, DO, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine the CT metal reduction technique that optimizes visualization of bone and soft tissue adjacent to a total shoulder arthroplasty.

METHOD AND MATERIALS

19 patients with TSA underwent dual energy CT (DECT). Post processing was performed for each study, creating 4 different image sets, each in soft tissue and bone kernels: (1) routine reconstruction (2) iterative metal reduction technique (iMAR) (3) DECT with virtual mono-energetic images at 130 keV and (4) combined iMAR and DECT virtual mono-energetic images at 130 keV. 2 experienced MSK Radiologists and 1 MSK Fellow blinded to processing data independently graded extent of artifact and image quality of one reconstruction for each patient, randomly ordered across 4 weekly reading sessions. A fifth reading session compared the 4 techniques side-by-side for each patient and a rank order preference was submitted. Attenuation measurements within bone and soft tissue at areas of greatest artifact near the hardware were collected for each reconstruction and compared to standard attenuation measurements collected from areas unaffected by artifact.

RESULTS

Of the four techniques utilized, iMAR combined with DECT with virtual mono-energetic images at 130 keV ranked best in overall image quality and in rank order preference by each of the 3 readers. The difference between attenuation measurements of bone and soft tissue in areas of greatest artifact and standard attenuation measurements was greatest in standard technique and lowest in iMAR combined with DECT Mono+.

CONCLUSION

In the setting of TSA, iMAR combined with DECT with virtual mono-energetic images at 130 keV objectively and subjectively decreases metal artifact when compared to standard reconstruction, iMAR alone and DECT with mono-energetic images at 130 keV alone.

CLINICAL RELEVANCE/APPLICATION

Orthopedic surgeons often utilize CT imaging to assess the necessity and nature of intervention. Metallic implants contribute to substantial artifact on CT imaging limiting visualization of adjacent structures. This is particularly relevant when trying to evaluate shoulder arthroplasties for evidence of loosening or fracture and to assess adjacent bone stock for revision surgery. This study demonstrates that utilization of iMAR with DECT with virtual mono-energetic technique in the setting of TSA provides optimal imaging quality of the adjacent osseous and soft tissue structures thus improving diagnostic evaluation.

SSQ13-09 Metal Artifact Reduction Using Spectral Dual-Energy CT with Virtual Monoengergetic Images for Patients with Metallic Orthopedic Implants of the Distal Radius

Thursday, Nov. 30 11:50AM - 12:00PM Room: E451A

Participants
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Hye Jin Yoo, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Sung Hwan Hong, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Ja-Young Choi, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose
Hee-Dong Chae, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the image qualities of virtual monoenergetic images obtained from spectral dual-energy CT (DECT) for patients with metallic orthopedic implants of the distal radius

METHOD AND MATERIALS

Forty-three consecutive patients with internal metallic implants for distal radius fracture underwent spectral DECT (33 women and 11 men, with a mean age of 50.7 ± 15.4 years (24-77 years). Sixteen virtual monoengergetic image sets ranging from 50 keV to 200 keV were generated at one single slice with the most pronounced hypodense streak artifacts of implants in axial plane. The image quality of sixteen monoengergetic images were assessed quantitatively and qualitatively by two independent musculoskeletal radiologists. Quantitative analysis included the density of most hypodense artifact and reference tissue, background image noise and artifact index (AI). Qualitative assessment included degree of artifacts, diagnostic image quality of peri-implent bones, and delineation of fracture lines if present. Friedman rank-sum test with post hoc tests and kappa analysis were used for the statistical analysis.

RESULTS

There was a statistically significant difference in CT number of most pronounced hypodense streak in peri-prosthetic region depending on monoenergy level ($p < 0.001$). There was a statistically significant difference in AI of most pronounced hypodense streak in periprosthetic region depending on monoenergy level ($p < 0.001$). AI of different monoenergy level was the lowest at 120-200 keV to provide the most significant metal artifact removal. The degree of artifacts, diagnostic image quality, and delineation of

fracture lines were significantly different among the keV settings (both $p < 0.001$). The hypodense streak in peri-prosthetic region was least pronounced at 110 keV and diagnostic image quality of peri-implant bones was best at 130 keV. Fracture lines were found in 22 patients, which was well delineated in all cases at 80~110 keV settings ($p < 0.001$).

CONCLUSION

Virtual monoenergetic images at high-energy levels have a well-concordant effect of reducing metal artifacts, and 110-130 keV monoenergetic images provided a least peri-implant artifact and best diagnostic image quality in patients with implants of the distal radius.

CLINICAL RELEVANCE/APPLICATION

Virtual monoenergetic images acquired from spectral DECT was useful to reduce metal artifacts caused by metallic implatns in patients with distal radius fracture

SSQ14

Nuclear Medicine (Endocrine and Musculoskeletal Imaging)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S504CD

CT MR MK NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants

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Matthew S. Robertson, MD, Cleveland, OH (*Moderator*) Nothing to Disclose

Sub-Events

SSQ14-01 Measurement Repeatability of Cold-Activated Brown Adipose Tissue Volume on [18F]FDG-PET Using both PET/CT and PET/MRI

Thursday, Nov. 30 10:30AM - 10:40AM Room: S504CD

Participants
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PURPOSE

Brown adipose tissue (BAT) is a promising target for anti-obesity interventions, which may entail induction of BAT volume expansion. Valid assessments of changes in BAT volumes require knowledge of intrinsic volumetric variability. Our aim was to determine the repeatability of cold-activated BAT volumes using [18F]FDG, the gold standard for detecting BAT activity, with both PET/CT and PET/MRI.

METHOD AND MATERIALS

To date, our study has enrolled 25 healthy volunteers (21 female, 4 male). As young, normal weight individuals are more likely to have detectable BAT, we included only subjects 18-35 y/o with BMI <= 25 kg/m2. A 5 mCi dose of [18F]FDG was injected midway through a 120 min cooling period, using a target temperature just above the shivering point. Subjects then underwent PET/CT immediately followed by PET/MRI. Imaging extended from the skull base to the upper abdomen, covering all common BAT areas. Repeat imaging occurred 2-7 days later per an identical protocol. BAT volumes were defined per BARCIST 1.0 criteria (Figure), incorporating a validated Dixon-based fat segmentation method for PET/MRI. Repeatability coefficients (RCs), based on percent differences between measurements (0% = perfect repeatability), were calculated.

RESULTS

Three subjects failed to complete the imaging protocol, and 6 had no detectable BAT. For the 16 evaluable subjects, RCs for BAT volumes (range, 24-315 ml) were 138.8% (PET/CT) and 98.8% (PET/MRI). Considering only the 8 subjects with the largest BAT volumes (range, 150-315 ml), RCs improved to 32.2% (PET/CT) and 36.4% (PET/MRI). The degree of BAT volume correlation between PET/CT and PET/MRI was significantly (p = 0.04) greater at baseline (R2, 0.96) than at repeat imaging (R2, 0.80). There was no difference (p = 0.88) in the degree of BAT volume correlation on serial PET/CT (R2, 0.85) compared with serial PET/MRI (R2, 0.87).

CONCLUSION

Volumetric repeatability was better for patients with more BAT. The higher degree of BAT volume correlation between PET/CT and PET/MRI on baseline imaging than between imaging sessions for either PET/CT or PET/MRI suggests that BAT activation factors (e.g., cooling protocol) may be a greater source of variability than imaging-related factors.

CLINICAL RELEVANCE/APPLICATION

Although repeatability of cold-activated BAT volumes on [18F]FDG-PET was acceptable for subjects with large amounts of BAT, further work is needed to improve the repeatability of small BAT volumes.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality

educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Richard L. Wahl, MD - 2013 Honored Educator

SSQ14-02 Localization of the Elusive Parathyroid Adenoma by 18F-choline PET/CT: Preliminary Results

Thursday, Nov. 30 10:40AM - 10:50AM Room: S504CD

Participants
Maria Tsakok, Oxford, United Kingdom (*Presenter*) Nothing to Disclose
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PURPOSE

Preliminary studies have shown choline-PET/CT to be of value in the preoperative localisation of parathyroid adenoma in primary hyperparathyroidism. Choline-PET/CT is used in our centre for patients with persistent hyperparathyroidism and in whom sestamibi scintigraphy, ultrasound, and either contrast enhanced CT or MRI, and venous sampling localisation investigations, and prior neck exploration have failed to identify the adenoma. This retrospective study aims to evaluate choline-PET/CT as a tool for localisation of parathyroid adenoma in a cohort of patients with repeatedly inconclusive conventional imaging.

METHOD AND MATERIALS

10 patients with biochemical hyperparathyroidism underwent choline-PET/CT. The findings were analysed and correlated with the prior localisation investigations. The reference standard was based on results of surgical exploration and histopathological correlation.

RESULTS

The patient cohort had undergone investigation for a mean of 5 years 3 months, had a mean of 9 previous localisation investigations (range 2-18) and a mean of 2 previous failed neck explorations (range 1-4), with 9/10 being symptomatic from their hyperparathyroidism. Choline-PET/CT identified likely causative lesions with relative certainty in 9/10 of cases. 7 cases had histologically-proven parathyroid adenoma following surgical exploration of the site identified by choline-PET/CT. A post-operative drop in serum parathyroid and/or calcium levels has been observed in all patients with positive histology.

CONCLUSION

In this challenging cohort of patients with persistent symptomatic hyperparathyroidism, with failed localization despite extensive non-invasive and invasive investigations, choline-PET/CT was able to accurately identify the location of the parathyroid adenoma in 70% cases, showing excellent promise as a second-line imaging tool.

CLINICAL RELEVANCE/APPLICATION

Choline-PET/CT shows initial promise at localising parathyroid adenoma in symptomatic patients with persistent primary hyperparathyroidism in whom conventional imaging has proved inconclusive.

SSQ14-03 Does the Risk of Development of Graves' Eye Disease after I-131 Therapy Depend On the I-131 Dosage?

Thursday, Nov. 30 10:50AM - 11:00AM Room: S504CD

Participants
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PURPOSE

Graves' ophthalmopathy, or Graves' eye disease (GED) is sometimes a manifestitation of Graves' disease. It is controversial in the medical literature as to whether or not GED can be precipitated or worsened by Radioiodine therapy with I-131 (RAI). The aim of this study was to determine if there is a relationship between the dosage of I-131 administered and the onset of GED.

METHOD AND MATERIALS

We reviewed the cases of all patients receiving RAI for Graves' disease for the last 5 years. Those patients who already had GED prior to RAI were excluded from this study. Follow-up was achieved by review of medical records as well as follow-up notes of the patients' ophthalmologists. The I-131 dosage of each patient and whether or not GED later developed was then recorded. The I-131 dosage calculation was based on a desired dose of 160-200 microcuries of I-131 per gram of thyroid tissue, ranging from 10 mCi to 25 mCi of I-131.

RESULTS

A total of 82 patients received RAI for Graves' disease. Eight patients had known GED prior to RAI, and 20 patients were lost to follow-up; therefore these 2 groups were excluded. Of the remaining 54 patients, 17 (31.5%) developed GED. The remaining 37 patients thus far have not. There was no correlation between the incidence of GED and the dosage of I-131 dispensed. Statistical analysis indicates only a 1% chance to observe a correlation greater than 0.30, based on the observed incidence.

CONCLUSION

There is no relationship between the likelihood of the onset of Graves' eye disease and the dosage of I-131 in the range of 10-25 mCi dispensed.

CLINICAL RELEVANCE/APPLICATION

In RAI therapy for Graves' disease, the I-131 dosage contemplated should not be influenced by the concern for the development of Graves' ophthalmopathy.

SSQ14-04 Two Weeks' Withdrawal of Inorganic Iodine Therapy is Appropriate for Radioiodine Therapy for Graves' Hyperthyroidism

Thursday, Nov. 30 11:00AM - 11:10AM Room: S504CD

Participants
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PURPOSE

Inorganic iodine therapy has been getting wide popularity as an adjunctive to anti-thyroid drugs (ATDs) in treating hyperthyroidism in countries where dietary iodine intake is sufficient. The aim of this study was to investigate whether 2 weeks' withdrawal of inorganic iodine therapy was appropriate for radioactive iodine I-131 therapy (RAI) for Graves' hyperthyroidism (GH).

METHOD AND MATERIALS

We used potassium iodide (KI) pill which contains 38mg of iodine per pill. 37 patients with GH (M 5/F 32. Age 42.6 ±13.9yrs), who had been pretreated by combination of ATD and KI and were to undergo RAI, were enrolled. Thyroid weight ranged from 26 to 97g. Dose of KI (mg/day) ranged from 50 to 300mg/day (average:141). KI was withdrawn 14 days prior to RAI while ATDs were withdrawn 3 to 4 days prior to RAI. Patient were instructed to follow low iodine diet from 7days before to 3 days after administration of I-131. As a parameter for total body iodine, urinary iodine concentration normalized by urinary creatinine (UIC: μg/gCRE) was measured before withdrawal of KI (UIC1) and on the day of RIA UIC2). Thyroid function and TRAb(IU/ml) were determined on the day of RIA. 24hr uptake of radioiodine (RU; %) was determined using gamma camera and I-123. All patients were followed up for more than 2years after RAI. Results of UIC, RU, and efficacy of RAI in patients (KI group) were compared with those in 39 patients with GH, who underwent RAI with pretreatment by ATD alone (ATD group).

RESULTS

The average value of UIC2 in KI group was less than 0.1% of UIC1(147330 vs. 131.9. p=0.0008), but was higher than that in ATD group (131.9 vs.89.0, p=0.032). However, difference in RU was not significant between KI group and ATD group (64.9 vs. 71.0, ns). There was a inverse correlation between UIC2 in KI group and RI (r=-0.523, p=0.045). Additionally, successful rate of RAI in KI group was comparable to that in ATD group (78 vs.82%, ns). TRAb value in KI group was higher compared to ATD group (22.9 vs. 15.1, p=0.013).

CONCLUSION

Pretreatment by KI does not impair therapeutic efficacy of RAI for GH if the drug is discontinued 2 weeks before administration of I-131 and is combined with a low iodine diet.

CLINICAL RELEVANCE/APPLICATION

Combination therapy of KI and ATD seems feasible as a pretreatment for radioiodine therapy for Graves' hyperthyroidism.

SSQ14-05 The Relationship among FDG Uptake: Thyroglobulin Doubling Time and Behavior of Tumor in Radioiodine Negative Metastasis from Thyroid Cancer

Thursday, Nov. 30 11:10AM - 11:20AM Room: S504CD

Participants
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PURPOSE

Recent studies have suggested that doubling time of serum Tg (Tg-DT) under TSH suppression may better predict prognosis of

postoperative thyroid carcinomas. Aim of the present study was to investigate relationship between FDG uptake and Tg-DT in radioiodine- negative metastasis from differentiated thyroid cancer (DTC).

METHOD AND MATERIALS

66 patients with metastatic thyroid cancer (PCA/FCA 64/5) who had received total thyroidectomy followed by radioiodine ablation and had negative I-131 scan results underwent FDG PET/CT. TgAb was negative in all patients. Location of metastatic tumor was lymph nodes in the neck and/or the mediastinum in 29, lung in 21, and both lymph nodes and lung in 16. Intensity of FDG uptake in the tumor was visually compared with that of the mediastinum to be determined as positive or negative. Additionally, tumors with positive FDG uptake were classified into 2 subgroups based on SUVmax (high uptake: SUV max>=5.0, low uptake: SUV Max<5.0). When a patient had more than 2 tumors, the largest tumor was used for evaluation of FDG uptake. Tg-DT was determined as previously described (Thyroid 2011; 21:707-716). All patients were followed up for 36-85 months. Imaging modalities including US, CT, MRI and/or PET/CT were performed at a regular interval to investigate relationship among FDG uptake, Tg-DT, and behavior of tumor.

RESULTS

FDG uptake was negative (N) in 16 pts., was low (L) in 28 pts., and was high (H) in the remaining 22 pts. The average of Tg-DT(yrs) in N group, L group, and H group were 9.1, 4.7, and 1.7, respectively. There were significant differences in Tg-DT between H group and other 2 groups ($p<0.001$ for L group and $p<0.01$ for). Additionally, more than 20% increase in the short diameter of the largest tumor and/or appearance of new lesions during the follow up period were seen in 0/16 (0%) in N group, 6/21 (26%) in L group, and 17/22(77%) in H group. 2 patients in H group showed rapid growth of metastatic tumors despite of longer Tg-DT(>3 yrs.).

CONCLUSION

Negative FDG uptake in metastatic tumors may indicate longer Tg-DT and stable disease for long period while tumors with high FDG uptake tend to have shorter Tg-DT and aggressive clinical behavior. FDG PET/CT correlates well with Tg-DT and is a valuable predictor for prognosis of metastasis from DTC.

CLINICAL RELEVANCE/APPLICATION

FDG PET/CT has a positive role as an alternative to Tg-DT in management of metastasis from thyroid cancer.

SSQ14-06 I-131 Thyroid Dosimetry in Patients with Abnormal Renal Function

Thursday, Nov. 30 11:20AM - 11:30AM Room: S504CD

Participants
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PURPOSE

Maximum permissible activity (MPA) of administered I-131 to treat thyroid cancer conventionally is estimated by combining whole body gamma camera & blood sample well counter measurements following oral administration of I-131. In attempting to simplify methodology by computing MPA from blood sample measurements, it is important to determine potential influence of various factors on methods used for estimating MPA. We retrospectively investigated the effects of previous treatment (PT) &/or abnormal renal function (AF) on MPA estimates derived from whole body counting and blood samples.

METHOD AND MATERIALS

Data were reviewed for 71 pts (age = 60±14 yrs; 38 female; 33 male) who previously had undergone total thyroidectomy for thyroid cancer and who were referred for pretreatment dosimetry to determine MPA. 30 pts (42%) had PT (PT+) & 41 pts (58%) did not (PT-), while 23 pts (32%) had AF (AF+) & 48 (68%) did not (AF-). Anterior & posterior whole body counts were measured by un-collimated gamma camera & blood samples were drawn & assayed in vitro by a well counter 1, 4, 24, 48, 72-96, & 96-144 hrs after 37-148 MBq I-131 administration to compute whole body γ & in-vivo ß dose contributions to compute conventional (Method1) total dose D, with MPA = 200 cGy/D. Linear regression comparing in-vitro blood sample measurements alone to conventional D yielded Method 2 predictions of D & MPA based on well counter blood measurements alone. Method 2 D & MPA were compared to conventional Method1 values by the paired t-test or Wilcoxon test & by linear regression.

RESULTS

MPA was similar for Method1 & Method2 for all 71 pts (21±14 versus 21±14 cGy/GBq, $p=0.97$), & for each pt subgroup: PT+ & AF- (N=24) MPA = 22±9 versus 22±9 GBq ($p=0.20$); PT- & AF- (N=24) MPA = 14±8 versus 14±8 GBq ($p=0.78$); PT- & AF+ (N=17) MPA = 8±2 versus 8±3 GBq ($p=0.92$); PT+ & AF+ (N=6) MPA = 7±3 versus 7±3 GBq ($p=0.29$). Correlation of Method2 to Method1 MPA was similar for PT-, PT+, AF- & AF+ subgroups ($r = 0.98, 0.99, 0.99$ & 0.94, respectively).

CONCLUSION

In pts with metastatic thyroid carcinoma or compromised renal function, MPA can be accurately estimated by measuring I-131 blood clearance, without the need to perform wholebody counting.

CLINICAL RELEVANCE/APPLICATION

Blood sampling alone suffices to estimate I-131 dose, regardless of renal function..

SSQ14-07 Utility of Fused Images by 99mtc-MDP SPECT and Low Dose CT in Detecting for Chronic-Infected Nonunion of the Lower Limb

Thursday, Nov. 30 11:30AM - 11:40AM Room: S504CD

Participants
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PURPOSE

To evaluate the benefits of using SPECT/CT fused images than using simple SPECT or CT in diagnosis and positioning of chronic-osteomyelitis nonunion of the lower limb.

METHOD AND MATERIALS

1.Patients are intravenous-injected typically 740-1110 MBq 99mTc-MDP. Images were acquired on a SPECT/CT (Dicovery™NM/CT670,GE) 2.The hybrid SPECT/CT system has a 16 slice multidetector CT. The SPECT was followed by CT examination with settings of 80-100 kV, 240 mAs, pitch-1. The CT images were reconstructed with 0.625mm slice thickness in multiplanar reformatting(MPR). 3.The author presents 36 cases of lower limb fracture nonunion, associated with or be suspicious of chronic osteomyelitis. For data analysis findings of three bone imaging models for every patients were categorized as yes(osteomyelitis), no(no osteomyelitis), or equivocal for the presence of osteomyelitis. Secondly, SPECT/CT fused imaging were compared to SPECT and CT with respect to localization ,extent of lesions, the body surface location consistency and the influence of internal and external fixed on each method.

RESULTS

The degree of interobserver agreement was evaluated by computing the kappa coefficient (κ=0.759 for SPECT/CT, κ=0.184 for CT, κ=0.192 forSPECT). Sensitivity of whole body bone scan for osteomyelitis was 52.2%, specificity 15.4%. Sensitivity of CT was 65.2%, specificity 23.1%. SPECT/CT fused images was sensitivity 91.3%, specificity 84.6%. It is the best choice in our study.Definition of anatomical localization of inflammatory foci was much easier by SPECT/CT fused images due to better description of anatomical details and concentration areas of eye-catching.

CONCLUSION

SPECT/CT fused images increased specificity than SPECT or CT.In distinguishing between soft tissue infection with osteomyelitis ,it is more accurate than only using SPECT. Hybrid SPECT/CT (With 16 row diagnositic CT)at the same time provide both anatomical and functions information. 99mTc-MDP SPECT/CT is more suitable for detecting osteomyelitis in China. Because it is more efficient, convenient(no special training), cheap than radiolabelled autologous white cells and 99mTc labelled monoclonal antibodies. Because of combination of SPECT and CT, radiation dose of patients has been increased. In order to reduce the radiation dose, the author adopts the method of low dose for lower limb CT scans(about 40% off).

CLINICAL RELEVANCE/APPLICATION

osteomyelitis

SSQ14-08 Correlation of Bone SPECT/CT and Plain Radiography with Clinical Findings in Painful Hip Prostheses

Thursday, Nov. 30 11:40AM - 11:50AM Room: S504CD

Participants
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PURPOSE

The concomitant use of plain radiography (PR) and bone SPECT/CT scans (BSCS) have greater potential to accurately detect complications after hip arthroplasty compared to each modality alone. We aimed to correlate patient-reported sites of pain with findings on BSCS and PR in patients with painful hip prostheses.

METHOD AND MATERIALS

A retrospective review of 12 consecutive patients with painful hip prosthesis who received BSCS was performed. The pain location and duration and prosthesis type, treatment, and surgical pathology were noted from nuclear medicine and orthopedic clinic reports. Each BSCS was interpreted side-by-side with the most recent hip PR obtained prior to each BSCS. The Gruen zones and De Lee and Charnley zones were noted for sites with increased uptake on BSCS. For each zone, an uptake ratio (UR) was measured as uptake intensity in counts/1.8 cm3 divided by a background uptake value of half the average uptake at the iliac crests, and a pixel value ratio (PVR) was obtained from dividing the average pixel value by a background pixel value of the adjacent normal bone-prosthesis or cement-prosthesis (BPCP) interface. Qualitative and quantitative grades were applied to sites of increased uptake on BSCS and areas of increased bone formation on PR.

RESULTS

In each case, UR on BSCS and PVR on PR were increased at each patient-reported site of pain upon evaluation with both qualitative and quantitative grading. The pain location had concordance rates of 83.3% with the zone of greatest PVR (10/12 cases) and 83.3% with the zone of highest UR (10/12 cases). The concordance rate between the zone of greatest PVR and the zone of greatest UR was 83.3%. Focal areas of increased bone formation/density on PR in the BPCP interface were noted

contralateral to the side of the prosthesis with loosening with BSCS demonstrating increased uptake in a pattern of prosthesis loosening.

CONCLUSION

Each patient-reported site of pain demonstrated increased uptake on BSCS and increased pixel value on PR. Focal areas of increased bone density contralateral to periprosthetic loosening sites may suggest loosening in the absence of the characteristic greater-than-2-mm radiolucent zone at the BPBC interface and be an earlier radiographic indication of loosening.

CLINICAL RELEVANCE/APPLICATION

Correlations between findings on BSCS and PR may help overcome interpretive challenges on either modality alone, important when only one modality is available.

SSQ14-09 F-18 FDG PET Trumps MRI on PET MRI evaluation of Diabetic Pedal Osteomyelitis

Thursday, Nov. 30 11:50AM - 12:00PM Room: S504CD

Participants
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Dinko Franceschi, MD, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose
Robert Matthews, MD, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The purpose of this study is to evaluate the relative senstivity of PET and MRI in diabetic osteomyelitis of foot as detected on PET MRI and confirmed by histopathological correlation.

METHOD AND MATERIALS

Retrospective evaluation of PET MRI imaging and correlation with histopathology was performed on 12 consecutive cases of suspected diabetic pedal osteomyelitis. On MRI imaging signal abnormalities were clasified as grade 0 (normal), grade I (edema) and grade II (confluent T1 hypointense signal).Grade II signal was diagnosed as osteomyelitis. Focal abnormal FDG uptake in the bones on PET was diagnosed as osteomyelitis. Of the 12 patients 10 (83.3%) had histopathological confirmation from surgery.

RESULTS

Ten of the twelve patients (83.3%) had osteomyelitis diagnosed on PET MRI which was confirmed at pathology (100% specificity). The two patients without evidence of osteomyelitis on PET MRI who were followed up were concluded not to have osteomyeltis according to clinical end points. Of the ten patients all ten had abnormal FDG uptake (100% senstivity FDG) localizing to bone. Only 7 of the 10 had MRI signal abnormalities Grade II represeneting osteomyelitis (70% senstivity MRI).Sites of pedal osteomyelitis included distal phalanges (N=6), tarsals (N=2), metatrasal (N=3) and calcaneus (N=1). Three of the ten patients had focal abscesses in the soft tissues.

CONCLUSION

FDG PET abnormalities on PET MRI are more senstive than MRI component for detection of diabetic osteomyeltis of the foot. Localisation to the bone however is only possible because of the simultaneous MRI accquistion which makes it an invaluable component of this modlaity.

CLINICAL RELEVANCE/APPLICATION

Diabetic osteomyelitis of the foot is a common problem that has significant clinical ramifications. Diagnosing osteomyelitis in diabetic foot especially on MRI and CT is complicated by preexisting chronic bony changes from neuropathy and non healing ulcers. Magnetic Resonance Imaging (MRI) is a useful modality for diagnosis of osteomyelitis and is more sensitive than CT. FDG PET is a very senstive modality for diagnosing osteomyelitis however in PET alone or PET CT anatomcal localisation to the bone is not optimal, a problem that is remedied by excellent anatomical detail on MRI. PET MRI serves as a one stop investigation for evaluation of osteomyeltis in diabetic foot.

SSQ15

Neuroradiology (Extracranial Vascular Imaging)

Thursday, Nov. 30 10:30AM - 12:00PM Room: N228

CT NR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Alexander M. McKinney IV, MD, Minneapolis, MN (*Moderator*) Nothing to Disclose

Sub-Events

SSQ15-01 Modified Blooming-Independent Dual-Energy CT Carotid Angiography for Calcified Plaque Removal: Comparison with Digital Subtraction Angiography

Thursday, Nov. 30 10:30AM - 10:40AM Room: N228

Participants
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PURPOSE

To investigate a new dual-energy computed tomography (DECT) technique with a modified 3-material decomposition algorithm for calcium removal in extracranial carotid artery stenosis.

METHOD AND MATERIALS

In this retrospective, IRB-approved study 30 calcified carotid plaques in 22 patients (15 males, mean age 73±10 years) with suspicion of stroke were included. DECT image data were obtained using second-generation dual-source CT with tube voltages at 80/140Sn kVp. Conventional CTA and virtual non-calcium (VNCa) images using the modified DECT algorithm were reconstructed. By assessing spectral characteristics, blooming-independent calcium removal was achieved. Two independent, blinded readers evaluated subjective image quality, blooming artifacts, amount of (residual) calcification, and performed stenosis measurements according to the NASCET-criteria. Differences were tested using a pairwise sign test. Paired sample t-tests with Bonferroni correction ($p<0.017$) and Bland-Altman analyses were used for assessing differences in stenosis measurements between VNCa and conventional CTA with digital subtraction angiography (DSA) as reference.

RESULTS

Subjective image quality was similar among conventional CTA and VNCa image datasets ($p=0.82$), while blooming artifacts were significantly reduced in VNCa images compared to conventional CTA ($p<0.001$). Residual calcifications in VNCa images were absent in 11 (37%), minor in 12 (40%), medium-sized in 2 (7%), and large in 5 (17%) arteries. Stenosis measurements differed significantly between VNCa (mean stenosis: 27±20%) and conventional CTA images (mean stenosis: 39±16%; $p<0.001$) and between conventional CTA and DSA (23±16%,$p<0.001$). No significant differences in stenosis measurements were observed between VNCa and DSA ($p=0.189$), with narrow limits of agreement (mean difference±1.96 SD,-4.7%; -35.13%; 25.71%).

CONCLUSION

The modified three-material decomposition DECT algorithm for blooming-independent calcium removal allows for an accurate removal of calcified carotid plaques in extracranial carotid artery disease.

CLINICAL RELEVANCE/APPLICATION

A novel, blooming-independent modified 3-material decomposition algorithm for calcium removal improves stenosis assessments by preventing overestimation of calcified stenosis in DECTA.

SSQ15-02 CT Texture of Carotid Arteries identifies Vulnerable Plaque in Stroke and Transient Ischaemic Attack: A Preliminary Outcome Study

Thursday, Nov. 30 10:40AM - 10:50AM Room: N228

Awards
Student Travel Stipend Award

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Andrea Laghi, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To assess the potential role of texture analysis in carotid arteries imaging.

METHOD AND MATERIALS

A retrospective case-control study. From a study population of 341 patients with CV risk factors that underwent whole-body CTA (detector configuration: 64x0.6mm; Iomeprol-400, 400mgI/ml; 70+50ml@4ml/s), 12 patients (age 63±10.29 yrs) with carotid atherosclerosis and a subsequent history of Transient Ischemic Attack (TIA) or Stroke were identified. These were age and sex matched with 12 control cases (age 62.9±10.16 yrs) with asymptomatic carotid atherosclerosis (follow-up 103.58±9.2 months). Stenosis and plaque composition were determined. Texture analysis was performed using a commercially available software (TexRAD, Somerset, UK) by a single operator blinded to clinical data. TexRAD uses a filtration-histogram based texture analysis technique to extract pixel size based (fine, medium, coarse) features and quantified histogram parameters including skewness (S) and normalized standard-deviation (SDn). A single axial slice was selected to best represent the carotid bifurcation for each side and a region of interest (ROI) was manually delineated in order to fully enclose the artery. Statistical analysis was performed using X2, t-test and Mann-Whitney test. ROC curves were constructed using TIA/Stroke as outcome.

RESULTS

Stenosis degree was greater at the right carotid bifurcation in the patient group (41.08 vs 12.08; p=.014), however no statistically significant differences were found at the left carotid bifurcation (p=.56); there were no differences in plaque composition for both sides (right p=.39, left p=.72). There was a statistically significant difference in Skewness at the fine and medium texture level (p=0.009 for spatial scaling factor (SSF) =2mm; p<0.001 for SSF=3mm and p=0.003 for SSF=4mm). SDn was statistically significant different between patients and control group for SSF=2mm (p=0.033). AUC values at SSF2 were .684 for SD and .723 for S (p values of .033 and .009 respectively); AUC values for S were .808 (p=.0001) at SSF3 and .075 (p=0.003) at SSF4.

CONCLUSION

CT texture identified vulnerable plaque in Stroke and TIA and may, therefore, have the potential to act as a new means of risk stratification in patients with carotid atherosclerosis.

CLINICAL RELEVANCE/APPLICATION

CT texture of carotid arteries may improve the identification of patients at risk for ischemic strokes.

SSQ15-03 Evaluation of Spectral Imaging in Craniocervical CT Angiography: Comparison with Conventional 120kVp CT Imaging

Thursday, Nov. 30 10:50AM - 11:00AM Room: N228

Participants
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PURPOSE

To evaluate the application of gemstone spectral imaging (GSI) protocol in craniocervical CTA by comparing the image quality and radiation dose with a conventional 120-kVp protocol.

METHOD AND MATERIALS

40 patients were scanned on Discovery CT750-HD (GE Healthcare) with parameters of 40mm helical 0.984:1, 360 mA, 0.6s rotation time. 20 patients underwent conventional 120 kVp scan and the other 20 were scanned using GSI mode, with monochromatic images of 60keV and 70keV being reconstructed. Both groups received 60 ml contrast agent of 350 mgI/ml with an injection speed of 4.5 ml/s. Objective image quality of the two groups was compared in terms of arterial enhancement and contrast-to-noise-ratio (CNR), which were measured at seven ROIs placed respectively in bilateral carotid artery bifurcation, basal artery, bilateral internal carotid artery C2 segment, and bilateral middle cerebral artery proximal end. Subjective image quality was evaluated using a 5 grade scale (5-excellent; 1-fail). The effective radiation dose (ED) was also recorded and compared. Data were analyzed by using independent-sample t-test.

RESULTS

As compared to 120kVp group, 60keV monochromatic images had significantly higher arterial enhancement (120kVp: 355±64.2 HU vs. 60keV: 483±81.1 HU, p<.001), comparable CNR (120kVp: 29±7.7 vs. 60keV: 29±7.5, p=.933), and significantly higher subjective image quality (120 kVp: 3.7±0.80 vs. 60keV: 4.5±0.51, p<.001). In contrast, 70keV monochromatic images did not differ from the 120kVp group in image quality of arterial enhancement (352±57.0 HU, p=.549), CNR (25±6.1, p=.085), or subjective image quality (3.7±0.80, p=.547). Radiation dose in GSI group (2.61mSv) reduced 27.5% compared with 120 kVp group (3.60mSv).

CONCLUSION

Compared with conventional 120 kVp scan protocol, 60keV GSI could reduce radiation dose, maintain CNR and improve subject

Compared with conventional 120 kVp scan protocol, 60keV GSI could reduce radiation dose, maintain CNR and improve subject image quality.

CLINICAL RELEVANCE/APPLICATION

The application of GSI mode in craniocervical CTA with appropriate single energy level could significantly reduce radiation dose while maintaining image quality.

SSQ15-04 Feasibility of 70kV and Adaptive Statistical Iterative Reconstruction V Technique in Low Dose Craniocervical CT Angiography

Thursday, Nov. 30 11:00AM - 11:10AM Room: N228

Participants
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PURPOSE

To investigate the feasibility of 70kV and adaptive statistical iterative reconstruction V (ASiR-V) to reduce radiation dose in wide-coverage craniocervical CT angiography , compared with 100kV

METHOD AND MATERIALS

This study was approved by the institutional review board. Written informed consent was waived. Twenty cases planned to craniocervical CT angiography was enrolled and randomly divided into two groups: A with 70kV and 40% ASiR-V(n=10), B with 100kV and 0%ASiR-V(n=10). Regions of interest (ROI) were placed on the thoracic inlet of carotid artery and cranial segment of carotid artery to measure the CT attenuation value and standard deviation (SD), the signal-noise-ratio (SNR) and contrast-noise-ratio (CNR) were calculated. Two experienced radiologists, who were blinded to the scan and reconstruction information, independently graded the CT images in terms of visibility and artifacts with a 4-grade rating scale. Dose length product (DLP) and effective radiation dose (ED) were recorded and calculated. Measurement data was compared with independent student T test, the concordance of image quality scores by the two radiologists was evaluated with kappa analysis, the image quality score was compared with Mann-Whitney U test.

RESULTS

The kappa value for the image quality scores from two radiologists was 0.618. The image quality score had no significant difference between two groups (3.80±0.42 vs 3.90±0.21, P=0.842). The effective radiation dose in group A was 59.5% lower that in group B (0.30±0.27mSv vs 0.74±0.15mSv, t=8.957, P<0.001). The CT value of carotid artery in group A was higher than that in group B (501.20±113.22HU vs 328.39±53.34HU,F=16.937,P=0.001). The SD value of of carotid artery in group A was higher than that in group B (25.53±3.01 vs 22.52±3.89 F=1.463,P=0.242). The SNR and CNR of carotid artery in group A was higher than that in group B(SNR, 19.84±4.87 vs 16.51±5.50, F=13.862,P=0.002; CNR, 32.22±10.01 vs 24.12±10.62, F=5.435,P=0.032).

CONCLUSION

Application of 70kV and adaptive statistical iterative reconstruction V (ASiR-V) can achieve approximate 60% radiation dose reduction and provide similar image quality compared with 100kV.

CLINICAL RELEVANCE/APPLICATION

Application of 70kV and adaptive statistical iterative reconstruction V (ASiR-V) can achieve approximate 60% radiation dose reduction and provide similar image quality compared with 100kV.

SSQ15-05 Who Is the Source of Redundant Imaging: Clinicians versus Radiologists?

Thursday, Nov. 30 11:10AM - 11:20AM Room: N228

Participants
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David M. Yousem, MD, Baltimore, MD (*Abstract Co-Author*) Royalties, Reed Elsevier; Royalties, Oakstone Publishing, LLC; Employee, Medicolegal Consultation; ; ;
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PURPOSE

Redundant neurovascular imaging studies such as Carotid US, CTA, MRA, and DSA may add cost to healthcare in the evaluation of patients with new neurologic deficits. However there has been an assumption that this is due to clinicians' mismanagement. We sought to determine to what extend such redundant studies are generated by radiologists' recommendations.

METHOD AND MATERIALS

The study was considered a quality improvement analysis and therefore did not require an IRB submission and was HIPAA compliant. The Radiology Information System was queried for the presence of carotid ultrasound, CT angiography, Digital Subtraction Angiography (DSA) and MR angiography occurring within 48 hours, 72 hours, and 7 days of each other in the setting of new neurologic symptoms during calendar year 2016. The reports were reviewed to determine how often 1) there were redundant studies and 2) radiologists recommended the additional studies.

RESULTS

3,300 exams from 2,939 patients conducted at both inpatient and outpatient clinics at three affiliated institutions from January 1, 2016 to December 31, 2016 were included in this study. Redundant studies occurred in 86/2939 (6.7%) of these 2939 patients. Of these 86 redundant studies, the radiology report contained a recommendation for another vascular study in 35 out of the 86 (40.7%). This included 15 cases of recommending MRA after CTA, 15 cases of DSA after CTA, 3 cases of DSA after MRA and 2 cases of US after CTA. The remaining 51 of the 86 redundant studies were driven by the clinical services, not radiologists.Of the 35 instances in which the radiologist recommended a second study, that second study confirmed the first study in 24/35 (68.6%) cases and disagreed with the first study in 11/35 (31.4%). Of the 51 cases of redundant studies generated by clinicians, 36/51 (70.6%) of the subsequent studies agreed with the first study and 15/51 (29.4%) were discrepant.

CONCLUSION

Of cases of redundant neurovascular imaging, the majority (59.3% = 51/86) are generated by clinicians, but radiologists recommended additional imaging in 40.7% of cases. When radiologists at our institution recommend additional radiological studies, 32/35 (91.4%) occurred following a CTA. Most second studies (68.6%) confirmed the first study's findings.

CLINICAL RELEVANCE/APPLICATION

Clinicians generate most redundant neurovascular studies but radiologists are responsible as well.

SSQ15-06 Optimizing Image Quality in Head and Neck CT Angiography with Spectral CT Optimal Monochromatic Image Technique

Thursday, Nov. 30 11:20AM - 11:30AM Room: N228

Participants
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PURPOSE

To study the use of the optimal monochromatic image technique in dual-energy Spectral imaging to optimize the image quality in head and neck CT angiography (CTA)

METHOD AND MATERIALS

28 patients were selected to undergo head and neck CTA using Spectral scan mode with patient body mass index (BMI)-dependent scan protocols (GSI-51 for BMI<23kg/m2 and GSI-1 for BMI>23kg/m2). After scanning, 5 sets of monochromatic images at 60, 65, 70, 75 and 80keV were reconstructed. Images were transferred to AW4.6 workstation for MPR, VR and CPR reconstruction. Two experienced radiologists evaluated the subjective image quality with a 4-point scoring system with the consistency of the scores evaluated by Kappa test. The CT values and their standard deviations of the aortic arch, common carotid artery, internal carotid artery, middle cerebral artery, cleidomastoid, and brain parenchyma were measured. The signal-to-noise ratio (SNR) and contrast to noise ratio (CNR) of the cervical vessels were calculated. Measurements in the 5 groups were compared by using the single factor variance analysis

RESULTS

The differences of SNR, CNR and subjective image scores among the 5 groups were statistically significant ($P < 0.05$). The average subjective image quality scores were the highest at 60keV (3.64±0.49) and 65keV (3.61±0.50) and the two observers had excellent agreement (Kappa>0.8). The highest SNR and CNR values were also obtained at these two energy levels. The SNR at 60keV and 65keV levels were (66.42±18.84 and 68.04±13.67) for the common carotid artery, (42.42±13.08 and 12.98±43.10) for the internal carotid artery and (45.51±12.47 and 45.52±11.47) for the middle cerebral artery. The respective CNR values were (77.22±24.10, 75.92±24.04), (77.31±25.47, 25.04±76.03), and (39.97±11.99, 39.45±11.05). The CT values at these two levels were all greater than 300HU for adequate vessel display.

CONCLUSION

The optimal energy levels in Spectral CT for head and neck CTA were at 60-65keV to provide adequate enhancement and to improve image quality.

CLINICAL RELEVANCE/APPLICATION

The optimal energy level technique in Spectral CT imaging may be used in head and neck CT to provide adequate enhancement and to improve image quality.

SSQ15-08 The Ability of Whole-Body CT to Detect Blunt Cerebrovascular Injury in a Large Trauma Patient Cohort: A Prospective Evaluation

Thursday, Nov. 30 11:40AM - 11:50AM Room: N228

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The purpose of this study is to assess the ability of whole-body CT (WBCT) to detect blunt cerebrovascular injury (BCVI) in a trauma paitient population.

METHOD AND MATERIALS

All trauma patients presenting to our institution between 8/1/2013 and 10/31/2016 were retrospectively identified from a radiology report database. Patients were 18-years of age or older; had sustained blunt trauma causing BCVI; and underwent WBCT imaging with neck CTA reconstructions at presentation. A 64-detector WBCT consisting of a chest CTA extending through the circle of Willis with 2 mm thick axial slices was performed, and neck CTA reconstructions with 1 mm thick axial slices and coronal, sagittal, and oblique MIP reconstructions were generated from WBCT source data. A neuroradiologist blinded to clinical history prospectively evaluated each WBCT, noting injury presence, location, and grade using the Biffl scale for BCVI grading. Following a 7 day washout period, neck CTA reconstructions were evaluated by the same rater in identical fashion. Twenty-one normal WBCT and neck CTA were randomly inserted into each respective group, and the reviewer was told that an unknown number of normal studies were present prior to evaluation. Sensitivity, specificity, and positive and negative predictive values were calculated with neck CTA findings serving as the reference standard.

RESULTS

During this study period, 3,392 trauma patients presented for WBCT with 118 trauma patients diagnosed with BCVI. Six patients were subsequently excluded due to poor image quality, resulting in a final cohort of 112 (3.3%) BCVI patients who met all inclusion criteria and possessed 133 individual vascular injuries. WBCT correctly detected 115 BCVI. Eighteen BCVI were missed by WBCT whereas 5 vessels were incorrectly identified as having BCVI. The sensitivity of WBCT for detecting BCVI was 86.5%, and its specificity was 76.2%. The positive predictive value was 95.8% and the negative predictive value was 47.1%. Of the 18 missed BCVI, 8 (44.4%) were grade I injuries, 9 (50.0%) were grade II injuries, and 1 (0.6%) was grade III. No grade IV injuries were missed.

CONCLUSION

WBCT is sufficiently sensitive and specific for detecting BCVI, with grade I and II injuries accounting for the majority of missed lesions.

CLINICAL RELEVANCE/APPLICATION

WBCT is sensitive enough to detect the majority of BCVI and should be used as a first-line screening tool in trauma patients.

SSQ15-09 Improving the Accuracy of Quantifying Carotid Atherosclerotic Plaques with High Definition Acquisition and Reconstruction

Thursday, Nov. 30 11:50AM - 12:00PM Room: N228

Participants
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PURPOSE

To investigate the accuracy of quantifying carotid atherosclerotic plaques with high-definition (HD) acquisition and reconstruction model on a high-definition computed tomography (HDCT) system.

METHOD AND MATERIALS

20 Patients with carotid stenosis and plaques (9 males, 11 females, mean age 66±0.46y) underwent HDCT carotid arteries angiography with a high-definition acquisition mode. Images were reconstructed with the high-definition algorithm with the new adaptive statistical iterative reconstruction (ASIR-V) at 50% strength (50% ASIR-V) and standard algorithm with 40% ASIR-V. The axial images of the two reconstructions were further processed to generate the maximum intensity projection (MIP) and multi-planar reconstruction (MPR) three-dimensional images. CT values, standard deviation (SD) in arteries and muscle and the areas of plaques, calcifications and the degree of stenosis in vessels were measured. Contrast-to-noise ratio (CNR) for the carotid arteries was calculated (CNR= (CT carotid arteries -CT muscle) / SD muscle. All measured data were compared using paired sample t test for statistical analysis using SPSS software,a=0.05 indicating significant difference.

RESULTS

73 plaques, including 28 calcified plaques, 23 mixed plaques and 22 soft plaques were identified in both standard and HD reconstructions. CNR values of two reconstruction methods were statistically the same (P>0.05). However, the area measurement for the calcified plaques with the HD reconstruction (3.60±3.00mm2) was statistically smaller than that with the standard reconstruction (4.27±3.45mm2) (p=0.02). There was no difference between the two reconstructions in the vascular stenosis degree (P = 0.129) and plaque area measurement (P = 0.598) .

CONCLUSION

High-definition acquisition and reconstruction on a HDCT system improves the accuracy of quantifying calcified carotid atherosclerotic plaques.

CLINICAL RELEVANCE/APPLICATION

High-definition acquisition and reconstruction on a HDCT system improves the accuracy of quantifying calcified carotid atherosclerotic plaques.

SSQ16

Neuroradiology (Cognitive and Psychiatric Disorders)

Thursday, Nov. 30 10:30AM - 12:00PM Room: N229

NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSQ16-01 Neurotransmitters in Young People with Internet and Smartphone Addiction: A Comparision with Normal Controls and Changes after Cognitive Behavioral Therapy

Thursday, Nov. 30 10:30AM - 10:40AM Room: N229

Participants
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PURPOSE

To reveal changes in neurotransmitters in internet and smartphone addicted youth compared with normal controls and after cognitive behavioral therapy, and to identify the correlations between neurotransmitters and affective factors related to addiction.

METHOD AND MATERIALS

Institutional review board approved this prospective study and informed consents were obtained. Nineteen young persons with internet and smartphone addictions consisted of 9 males and 10 females and their mean age was 15.47±3.06 years. Nineteen gender and age-matched healthy controls were also included. Nine weeks cognitive behavioral therapy was administered to 12 addicts ages 11 to 17 years. MEGA-press MRS was used to measure GABA and glutamate-glutamine (Glx) levels in the anterior cingulate cortex. GABA and Glx levels in the addicted group were compared to controls and after 9 weeks of cognitive behavioral therapy. GABA and Glx levels were correlated to clinical scales of internet and smartphone addictions, impulsiveness, depression, anxiety, insomnia and sleep quality.

RESULTS

Brain-parenchymal and gray-matter volume adjusted GABA to creatine ratios (p=0.028 and 0.016) and GABA to Glx ratios (p=0.031 and 0.021) were significantly increased in internet and smartphone addictions. After 9 weeks of cognitive behavioral therapy, brain-parenchymal and gray-matter volume adjusted GABA to creatine ratios (p=0.034 and 0.026) and brain-parenchymal volume adjusted GABA to Glx ratio (p=0.05) were significantly decreased. Glx was not statistically significant. Most brain-parenchymal and gray-matter volume adjusted GABA to creatine ratios and GABA to Glx ratios were significantly correlated with clinical scales of internet and smartphone addictions, depression and anxiety.

CONCLUSION

The increased GABA level and disrupted balance between GABA and glutamate in the anterior cingulate cortex may contribute to understanding the pathophysiology of and treatment for internet and smartphone addictions. Correlations between neurotransmitters and psychology tests in internet and smartphone addictions may reveal the relation and solution to their psychological comorbidities.

CLINICAL RELEVANCE/APPLICATION

The increased GABA in internet and smartphone addicted youth and its decrease after cognitive behavioral therapy will be useful to reveal the neurobiology of comorbidities and treatment.

SSQ16-02 Spontaneous Low-Frequency Fluctuations in Neural System for Emotional Perception in Major Psychiatric Diagnostic Categories: Amplitude Similarities and Differences across Frequency Bands

Thursday, Nov. 30 10:40AM - 10:50AM Room: N229

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PURPOSE

Growing evidence indicates shared and distinct emotional perception in schizophrenia (SZ), bipolar disorder (BD), and major depressive disorder (MDD). The alterations of spontaneous low-frequency fluctuations have been increasingly reported in emotional perception neural system in these disorders. However, it is unknown what similarities and differences of their amplitudes (ALFF) are across SZ, BD, and MDD.

METHOD AND MATERIALS

ALFF and its signal balance between two frequency bands (slow-5 and slow-4) within emotional perception neural system were compared across 119 SZ, 100 BD, 123 MDD, and 183 healthy control (HC) participants. Exploratory analyses were performed to determine the relationship between an ALFF balance and clinical variables.

RESULTS

Commonalities in ALFF change pattern were observed across three disorders in emotional perception neural substrates, such as increased ALFF in the anterior cerebrum, including subcortical, limbic, paralimbic, and heteromodal cortical regions, and decreased ALFF in the posterior visual cortices. SZ, BD, and MDD showed significant decreased ALFF signal balance within emotional perception neural system in both slow-5 and slow-4, with greatest alterations in SZ, followed by BD, and then MDD. A negative correlation was shown between the ALFF balance and negative/disorganized symptoms in slow-4 across SZ, BD, and MDD.

CONCLUSION

Our findings suggest that the extent of observed commonalities herein further support the presence of core neurobiological disruptions shared among SZ, BD, and MDD. ALFF signal balance might be considered as an important neuroimaging marker for the future diagnosis and treatment in these major psychiatric disorders.

CLINICAL RELEVANCE/APPLICATION

Our major findings suggest that the extent of observed commonalities herein further support the presence of core neurobiological disruptions shared among SZ, BD, and MDD. The balance of ALFF signals within emotional perception neural system might be considered as an important neuroimaging marker for the future diagnosis and treatment in these major psychiatric disorders.

SSQ16-03 The Impact of Apolipoprotein E Gene Polymorphism on the Cerebral Blood Flow in Patients with Mild Cognitive Impairment

Thursday, Nov. 30 10:50AM - 11:00AM Room: N229

Participants
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PURPOSE

We sought to investigate whether the apolipoprotein E (APOE) genotype specifically modulates cerebral blood flow in patients with amnesic mild cognitive impairment (aMCI) by using the pulsed arterial spin labeling (ASL) data.

METHOD AND MATERIALS

83 aMCI and 130 healthy controls (HC) underwent neuropsychological battery assessments, genetic screening and MRI scanning. ASL data preprocessing was carried out using the ASLtbx toolbox. A voxel-wise two-way ANOVA was performed to examine the main effects of diagnosis (aMCI vs. HC) and APOE genotype (ε2 vs. ε3ε3 vs. ε4), and the diagnosis-by-genotype interactions on CBF maps. Then, we performed multiple linear regression analyses to examine the relationships between the neuropsychological test scores and CBF values in brain areas showing significant diagnosis-by-genotype interactions.

RESULTS

(1) Significant diagnosis-by-genotype interactions on CBF were observed in the left superior frontal gyrus , right anterior cingulate/medial prefrontal cortex and bilateral superior temporal gyrus. Post-hoc pairwise analysis revealed that compared with the ε2 carriers and ε3ε3 carriers, the ε4 carriers had significant higher CBF values in the above areas in the aMCI group, but there were no significant genotype differences in the HC group. (2) APOE ε4 carriers showed significant higher CBF values in the right anterior and posterior cingulate cortex than the ε2 carriers and ε3ε3 carriers respectively; (3) Compared with HC group, the aMCI group exhibited higher CBF values primarily in the left superior and middle frontal gyrus. (4) We found that the CBF values in the right anterior cingulate/medial prefomtal gyrus and superior temporal gyrus were negatively correlated with the similarity test scores ($r = -0.453$, $P = 0.014$; $r = -0.497$, $P = 0.006$).

CONCLUSION

The APOE genotype has diaease-specific effects on cerebral perfusion; the increased CBF within the lateral prefrontal and temperal cortex in the aMCI ε4 carriers may be interpreted as reflecting greater cognitive "effect" by aMCI ε4 carriers to achieve the same

level of performance as aMCI ε4 non-carriers (e.g., ε2 carriers and ε3ε3 carriers).

CLINICAL RELEVANCE/APPLICATION

(dealing with functional MR and cortical activation) ' fMRI may lay a foundation for the perfusion index of AD early diagnosis , disease severity, the following-up of AD and drug efficacy determination.'

SSQ16-04 Interaction of Systemic Oxidative Stress and Mesial Temporal Network Degeneration in Parkinson's Disease with and without Cognitive Impairment

Thursday, Nov. 30 11:00AM - 11:10AM Room: N229

Participants
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PURPOSE

Systemic oxidative stress is the well-investigated factor and contributes to neuroinflammation of Parkinson's disease (PD). Cognitive impairments in PD are strong-associated with mesial temporal lobe (MTL) dysfunction. In the present study, we sought to evaluate the relationship between systemic oxidative stress and MTL function by measuring the morphology and functional network alteration in PD patients with and without cognitive impairment.

METHOD AND MATERIALS

Forty-one patients with PD (subgrouping into 3 groups [PD-normal, PD-mild cognitive impairment, PD-dementia]) and 29 normal control volunteers underwent peripheral blood sampling to quantify systemic oxidative stress markers, and T1W volumetric and resting state functional MRI (rs-fMRI) scans. Rs-fMRI was used to derive the healthy intrinsic connectivity patterns seeded by the epicenter vulnerable to any of significant oxidative stress markers. The functional connectivity correlation coefficient (fc-CC) and gray matter volume (GMV) of the network seeded by the epicenter among groups were compared. The correlation analysis among fc-CC, GMV and cognitive impairment were performed.

RESULTS

The oxidative stress markers including leukocyte apoptosis and LFA-1 values were significantly higher in the PD group. Using whole brain VBM based correlation analysis, bilateral MTL were identified as the most vulnerable epicenters of lymphocyte apoptosis ($p < 0.005$). The following resting state functional connectivity analysis further revealed the MTL network seeded by the epicenter. The MLT network of normal connectivity profile was resembled the PD-associated atrophy pattern. The GMV of the MTL network also demonstrated the significant difference between groups. Reduced fc-CC and GMV were associated with the progressed cognitive impairment.

CONCLUSION

The epicenters vulnerable to lymphocyte apoptosis can be linked to an altered MTL network that modifies both architecture and functional connectivity, with relationship to cognitive impairment. The possible relations among them may represent consequent cognitive impairment processes of systemic oxidative stress and MTL network injuries in PD patients.

CLINICAL RELEVANCE/APPLICATION

The volumetric and re-fMR can demostrate damages of MTL network vulnerable to oxidative stress.

SSQ16-05 Effects of Mentally Stimulating Activities Training On Resting-State Network Functional Connectivity in Amnestic Mild Cognitive Impairment: A Pilot Controlled Trial

Thursday, Nov. 30 11:10AM - 11:20AM Room: N229

Awards
Student Travel Stipend Award

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PURPOSE

To explore the resting-state network functional connectivity alterations in patients with amnestic mild cognitive impairment(aMCI)before and after mentally stimulating activities training.

METHOD AND MATERIALS

Cognitive diagnosis was made by an expert consensus panel based on previous published criteria. Thirty-eight elderly subjects with aMCI comprising of training group (18) and control group (18), with age-, sex- and MoCA score-matched participated in this study. Rest-state fMRI (rs-fMRI) and neuropsychological assessment were conducted at baseline and after 6-month following training/control program. The global functional connectivity of rs-fMRI was analysed based on the graph theoretical modeling and seed-based analysis. The changes of functional connectivity and neuropsychological scores were compared between the two groups.

RESULTS

After 6-month training/control program, the MoCA score was significantly increased in training group (25.53±2.51) compared with the control group (21.81±2.02). Based on the graph theoretical modeling, the bilateral angular gyrus presented positive connectivity with the global brain in training group. Seed-based analysis, functional connectivity between the hippocampus and a set of regions was decreased in training group, these regions are: the right angular, cingulate gyrus and praecuneus; While, the left supplement motor area showed increased connectivity to the hippocampus.

CONCLUSION

These findings would be helpful to aid our understanding of the neurofunctional mechanisms associated with effects of mentally stimulating activities training on the cognitive function in aMCI.

CLINICAL RELEVANCE/APPLICATION

The network functional connectivity analysis of resting-state fMRI maybe a potentially useful tool for exploring the mechanism of mentally stimulating activities in aMCI.

SSQ16-06 Multi-voxel Pattern Analysis with Large-scale Granger Causality to Investigate Brain Connectivity Changes in Resting-State Functional MRI of Patients with HIV-Associated Neurocognitive Disorder

Thursday, Nov. 30 11:20AM - 11:30AM Room: N229

Participants
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PURPOSE

To develop and evaluate a novel machine learning framework using large-scale Granger causality (lsGC) for identification of subjects with HIV-Associated Neurocognitive Disorder (HAND) by capturing differences in resting-state functional MRI (rsfMRI) connectivity.

METHOD AND MATERIALS

Resting-state fMRI scans (3T, EPI sequence, TR=1.65s, 250 acquisitions) were acquired in a cohort of 45 age-matched subjects (20 healthy, 25 HIV+ of which 16 had HAND symptoms (HAND+)). After pre-processing, data was parcellated into regions defined by the Automated Anatomical Labeling (AAL) atlas. Regions were represented by their average time-series. A novel multivariate directional extension of Granger causality, lsGC, quantified the interdependence between time-series. Generalized matrix learning vector quantization, a method that combines supervised machine learning with embedded feature selection was used to classify HAND+ and healthy subjects from the resulting connectivity matrix in a Multi-Voxel Pattern Analysis (MVPA) framework. Strict data separation (90% train/10% test) was carried out in a 100-iteration cross-validation scheme. As a standard reference method, we used conventional multivariate Granger Causality (mGC) for comparative evaluation. Area Under the Curve (AUC) for Receiver Operator Characteristics (ROC) analysis and prediction accuracy were used to quantitatively evaluate the diagnostic quality of HAND+ subject classification.

RESULTS

Our novel lsGC rsfMRI connectivity analysis approach outperformed mGC in identifying HAND+ subjects, with AUC = 0.86 ± 0.29 and accuracy = 0.88 ± 0.17% for lsGC compared to AUC = 0.70 ± 0.35 and accuracy = 0.64 ± 0.25% for the conventional mGC method, respectively. Diagnostic quality differences between both methods were statistically significant ($p < 0.01$, Wilcoxon signed-rank test) for both AUC and prediction accuracy.

CONCLUSION

Our results suggest that the novel lsGC analysis method significantly improves the diagnostic quality for identification of patients with HAND. We conclude that, when compared to conventional mGC analysis, our MVPA framework is better suited to capture disease-related brain network connectivity changes based on rsfMRI neuroimaging.

CLINICAL RELEVANCE/APPLICATION

Our framework identifies HAND+ subjects by revealing disease-related changes in brain connectivity patterns, which can serve as a useful diagnostic biomarker in HIV-related neurologic disease.

SSQ16-07 The Altered Resting-State Functional Connectivity and Regional Homogeneity in Type 2 Diabetes with Mild Cognitive Impairment

Thursday, Nov. 30 11:30AM - 11:40AM Room: N229

Participants
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PURPOSE

Patients with Type 2 Diabetes Mellitus (T2DM) have considerably higher risk of developing cognitive impairment and dementia. This

Patients with Type-2 Diabetes Mellitus (T2DM) have considerably higher risk of developing cognitive impairment and dementia. This study aims to investigate the possible alterations in spontaneous neural activity of brain through resting state-functional MRI (rs-fMRI) in T2DM patients with and without mild cognitive impairment.

METHOD AND MATERIALS

Eighteen T2DM patients with mild cognitive impairment (DM-MCI) and 18 matched T2DM patients with normal cognition (DM-NC) were enrolled. On a 3 Tesla scanner, rs-fMRI data were obtained axially using a gradient-echo planar imaging sequence. Using the Brainnetome toolkit (BRAT) (www.brainnetome.org/en/brat) and SPM8 software, the regional homogeneity (ReHo) was calculated to represent spontaneous brain activity in different brain areas. ReHo changes were correlated with neuropsychological scores and disease duration. Based on the anatomically labeled (AAL) template, the whole-brain partitional analysis on functional connectivity was also applied to search for significant links.

RESULTS

Compared to DM-NC group, DM-MCI group exhibited decreased ReHo value in the right inferior, middle, and superior temporal gyrus; but increased ReHo value in the bilateral superior and medial frontal gyrus, the right orbital gyrus and the inferior frontal gyrus(fig.1). In the DM-MCI group, ReHo value was negatively correlated with Montreal Cognitive Assessment scores in the left medial frontal gyrus (R=-0.662, p=0.01), and positively correlated with diabetes duration in the right inferior and middle frontal gyrus (R=0.594, p=0.026)(fig.2). Correlation between ReHo and glycosylated hemoglobin A1c was not significant. The DM-MCI group showed 11 pairs of weaker functional connectivity between different brain areas (p<0.01, FDR corrected)(fig.3).

CONCLUSION

The abnormal brain activity reflected by ReHo measurements and the weaker functional connectivity of multiple brain regions could help uncover the susceptible regions of T2DM patients who progress into cognitive dysfunction, and may provide insights into the pathogenesis of T2DM related cognitive impairment.

CLINICAL RELEVANCE/APPLICATION

Resting state-fMRI may be able to track early progression of brain functional alterations, and can be an appropriate approach for studying the spontaneous brain activity in diabetes related cognitive impairment.

SSQ16-08 Early Volume Reduction of Hippocampus after Whole-Brain Radiation Therapy: Automated Brain Structure Segmentation Study

Thursday, Nov. 30 11:40AM - 11:50AM Room: N229

Participants
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PURPOSE

It is well known that cognitive decline often occurs after whole-brain radiation therapy (WBRT), especially in the long survivors. Our hypothesis was that the hippocampus is vulnerable to radiation and may become atrophic even at early stage after WBRT. Therefore, using automated segmentation of brain structures, we assessed volume changes of the various brain structures including the hippocampus within 10 months after WBRT.

METHOD AND MATERIALS

Twenty patients with lung cancer who underwent both WBRT and chemotherapy were recruited as a WBRT group. As a control group, 18 patients with lung cancer who underwent only chemotherapy were also recruited. Pre-treatment MRI was performed within one month before radiation or chemotherapy, and post-treatment MRI were performed 6 to 10 months after the radiation or chemotherapy. Contrast enhanced high-resolution 3D T1-weighted images of pre- and post-treatment were analyzed using longitudinal processing of FreeSurfer. We calculated volume reduction ratios [{(volume of pre-radiation - volume of after radiation)/ volume of pre-radiation}x100] for the whole-brain cortex and white matter, hippocampus, and amygdala defined by Aseg atlas in FreeSurfer.

RESULTS

In the WBRT group, the hippocampus showed significant volume reduction (5.7%, $p < 0.01$), while the whole-brain cortex and white matter, and amygdala did not show significant volume reduction (4.9%; $p = 0.21$, 1.3%; $p = 0.19$, 1.3%; $p = 0.95$, respectively). The volume reduction ratio of the hippocampus was significantly higher than those of the whole-brain cortex and white matter ($p = 0.01$ and 0.02, respectively). In the control group, there was no significant volume reduction in any regions (the ratios: 0.3%, 1.0%, 1.0%, and 0.9% for the hippocampus, amygdala, whole-brain cortex and white mater, respectively).

CONCLUSION

Among the whole-brain cortex and white matter, hippocampus, and amygdala, only the hippocampus showed significant volume reduction within 10 months after WBRT suggesting its vulnerability to radiation.

CLINICAL RELEVANCE/APPLICATION

Our study may support the validity of the "hippocampus-sparing" WBRT to prevent the radiation-induced cognitive impairment.

SSQ16-09 Nonlinear Modulation of Interacting Between COMT and Depression on Brain Function

Thursday, Nov. 30 11:50AM - 12:00PM Room: N229

Participants
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PURPOSE

The catechol-O-methyltransferase (COMT) gene is related to dopamine degradation and has been suggested to be involved in the pathogenesis of major depressive disorder (MDD). However, how this gene affects brain function properties in MDD is still unclear.

METHOD AND MATERIALS

Fifty patients with MDD and 35 cognitively normal participants were underwent a resting-state functional magnetic resonance imaging scan. A voxel-wise data-drive global functional connectivity density (gFCD) analysis was used to investigate the main effects and interactions of disease states and COMT rs4680 on brain function.

RESULTS

We found significant group differences on the gFCD in bilateral fusiform area (FFA), postcentral and precentral cortex, left superior temporal gyrus (STG), rectal and superior temporal gyrus, right ventrolateral prefrontal cortex (vlPFC), and the abnormal gFCDs in left STG was positively correlated with depressive severity in MDD patients. Significant disease × COMT interaction effects were found in the bilateral calcarine gyrus, right vlPFC, hippocampus, and thalamus, and left SFG and FFA. Further post-hoc tests showed a nonlinear modulation effect of COMT on gFCD in the development of MDD. Interesting, an inverted U-shaped modulation was showed in the prefrontal cortex (control system), while U-shaped modulations were found in the hippocampus, thalamus and occipital cortex (processing system).

CONCLUSION

Our study manifested a nonlinear modulation of interacting between COMT and depression on brain function. This findings expand our understudying of the COMT effect underlying pathophysiology in MDD patients.

CLINICAL RELEVANCE/APPLICATION

The brain functional features detecting combined with COMT genotyping may provide a useful biomarker to the occurrence and development of depression.

SSQ17

Science Session with Keynote: Pediatrics (Neuroradiology)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S103CD

MR NR PD

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Daniela Prayer, MD, Vienna, Austria (*Moderator*) Nothing to Disclose

Sub-Events

SSQ17-01 Pediatrics Keynote Speaker: Pediatric Neuroimaging in the Age of Precision Medicine

Thursday, Nov. 30 10:30AM - 10:40AM Room: S103CD

Participants
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SSQ17-02 Association of Childhood Obesity with the Central Nervous System (CNS): Study of Diffuse Tensor Imaging (DTI)

Thursday, Nov. 30 10:40AM - 10:50AM Room: S103CD

Participants
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PURPOSE

The aim of this work is to investigate the influence of childhood obesity on changes in anatomy and cerebral connectivity, using the DTI by Magnetic Resonance Imaging (MRI). The hypothesis is that the brain is an organ also affected by high adiposity, particularly the hypothalamus, which is a complex region involved in the regulation of appetite and hormonal homeostasis.

METHOD AND MATERIALS

The images were obtained on Achieva 3T Phillips Magnetic Resonance. The sample for statistical analysis consisted of 120 subjects: 59 obese adolescents and 61 healthy adolescents, aged 11 years to 18 years, and matched regarding gender, age, and schooling. The images were processed with the FSL-Tbss (Tract Based Spatial Statistics) program and analyzed statistically by the same program with Randomize.

RESULTS

Statistical analysis showed decrease in the values of Fractional Anisotropy (FA) of obese pediatric patients compared with healthy controls in amygdala, hippocampus, thalamus, cingulate gyrus, fornix, insula, putamen, orbital gyrus and bilateral hypothalamus. There was no region of higher FA in obese patients in relation to the control group.

CONCLUSION

The data reveal a pattern of involvement in important regions in the control of appetite and emotions. Limbic structures, such as amygdala, hippocampus, thalamus, cingulate gyrus, fornix and insula are altered. Important regions related to impulse control, reward and pleasure in eating (putamen and orbital gyrus) and autonomic appetite control (bilateral hypothalamus) were also shown to have decreased FA.

CLINICAL RELEVANCE/APPLICATION

Childhood obesity is a subject of high clinical importance, and presents data of ascent from 10 to 40% of the last 10 years in most countries. Previous studies have pointed to obesity as a risk factor for neurodegenerative disorders through DTI tractography. In this way, we investigated previous or early cerebral changes in obesity.

SSQ17-03 Voxel-Based Morphometry (VBM) and Tract-Based Spatial Statistics-Diffusion Tensor Imaging

(TBSS-DTI) in Rett Syndrome: Alterations in Visuomotor Areas and Limbic System

Thursday, Nov. 30 10:50AM - 11:00AM Room: S103CD

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PURPOSE

Rett syndrome (RTT) is a neurodevelopmental disorder presenting with loss of motor and speech abilities, stereotypic movements, gait disturbance, autistic behavior and seizures. We aimed to investigate underlying morphometric and white matter (WM) changes in patients with RTT using MRI.

METHOD AND MATERIALS

IRB approved this study and all the participants/ parents gave signed consent form. T1-weighted 3D images (MPRAGE) (TR/TE/TI: 1910/3,5/1100ms) and diffusion tensor imaging (DTI) of the brain along 60 non-collinear directions (TR/TE: 5814 /98 ms, bmax:1000s/mm2) were obtained from 15 female patients with classical Rett syndrome and MECP2 mutation, and 14 healthy age and sex-matched subjects (median ages, 3.99 and 5.08 respectively; p>0.95). We used SPM12 for voxel-based morphometry (VBM) and TBSS, a part of FSL 4.0 software package for voxel-wise statistical DTI analysis. From VBM analysis, segmented GM, WM and CSF volume, total intracranial volume (TIV), and normalized volumes by diving to TIV were measured. Statistically significant clusters in VBM and TBSS-FA map (all, FEW correction, p<0.05) were determined using MNI atlas.

RESULTS

Although GM, WM, CSF volumes were significantly smaller in patients (p<0.02), the significance didn't remain in comparison of normalized volumes (p>0.1). Patients showed significantly reduced WM density in frontal and parieto-occipital areas related with visuomotor coordination, sensorimotor areas and cognition; also significantly less GM density in superior and middle temporal gyri and left prefrontal cortex (p<0.05). Patients showed reduced FA in the cerebellar hemispheres, corpus callosum, inferior frontooccipital fascicles, anterior thalamic radiations, thalami, external capsules, fornices, cinguli, superior longitudinal fascicles (p<0.05).

CONCLUSION

When normalized to TIV, no significant volume loss was observed in patients with RTT. VBM and TBSS-DTI revealed mostly WM density and FA reductions in bilateral visuomotor areas and limbic system components such as cingulum and fornices related with cognition, behavior and seizures.

CLINICAL RELEVANCE/APPLICATION

Multimodal neuroimaging link structural and connectivity alterations related with diverse clinical features in patients with RTT.

SSQ17-04 Preterm Neonates Show a 'Catch-Up' Pattern toward Term in Motor Development during the Neonatal Period: A Diffusion Tensor Imaging Study

Thursday, Nov. 30 11:00AM - 11:10AM Room: S103CD

Participants
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PURPOSE

To detail the postnatal trajectory of neonatal sensorimotor functions by comparing the postnatal age-related changes of brain white matter (WM) microstructure and neurobehavioral abilities between preterm and term neonates during the neonatal stage.

METHOD AND MATERIALS

118 neonates (within 28 days after birth) with no abnormality who underwent conventional MRI and DTI were included (Table1). The DTI-derived fractional anisotropy (FA) and neonatal neurobehavioral assessment were separately used to characterize the brain WM microstructure and neurobehavioral development levels. The scatterplot with linear fitting was used to investigate the relations of FA and neurobehavioral scores (active tone and behavior) with postnatal age (day), setting gestational age (GA) as a covariate. Here, OR (optical radiation), AR (auditory radiation), CST (corticospinal tract), PTR (posterior thalamic radiation) and thal-PSC (thalamus-primary somatosensory cortex) were selected as regions of interest; active tone and behavior were used to separately evaluate the abilities of motor and integrated visual, auditory and sensory. All statistical analysis were performed by using Matlab; p<0.05 was considered as statistically significant difference.

RESULTS

Significant correlations of adjusted FA with postnatal age were found in preterm CST (p=0.042), term OR (p=0.018) and PTR

Significant correlations of adjusted FA with postnatal age were found in preterm CST ($p=0.042$), term OR ($p=0.018$) and PTR ($p=0.002$). Compared to term neonates, preterm showed an obviously higher correlation in CST (0.29 vs 0.08), while less correlations in visual, auditory and somatosensory-associated WMs (Figure 1). Being relatively consistent, neurobehavioral results indicated that preterm neonates presented relatively higher and lower correlations than term in active tone (0.48 vs 0.35) and behavior scores (0.36 vs 0.52), respectively (Figure 2).

CONCLUSION

Although being delayed, preterm neonates show a 'catch-up' pattern toward the term in motor development during the neonatal period.

CLINICAL RELEVANCE/APPLICATION

Postnatal trajectory of neonatal sensorimotor function e.g. preterm 'catch-up' motor development provide valuable references in guiding the early intervention and thus gaining more effective outcomes.

SSQ17-05 Visually Accessible Rembrandt Imaging (VASARI) Features Predict Survival and Identify Distinct Groups of Pediatric High Grade Glioma

Thursday, Nov. 30 11:10AM - 11:20AM Room: S103CD

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PURPOSE

To understand the relationship of Visually Accessible Rembrandt Imaging (VASARI) features to prognosis and disease subgroups in pediatric high grade glioma (pHGG).

METHOD AND MATERIALS

Seventy one consecutive cases of newly diagnosed pHGG were systematically reviewed and scored for VASARI features by two expert radiologists. Agreement between reviewers was scored for each VASARI feature. The inter-correlation between VASARI features and impact on hierarchical clustering of patients were evaluated. The distance between variables is as follows; Pearson correlation was used among the continuous variables, Kendall's correlation was used among binary/ordinal variables, and Spearman correlation was used between continuous variables and binary/ordinal variables. Pearson correlation was used to measure the distance between subjects. The number of clusters was determined using the hybrid method proposed by Langfelder and Zhang (2008). Patient clusters were evaluated for their subgroup specific survival. Analyses were completed in either SAS v9.3 or R 3.3.3.

RESULTS

The median concordance between reviewers for VASARI features was 60% (range, 29-79%). The most concordant features include tumor location, diffusion characteristics, and pial invasion, while the most discordant features were ependymal invasion, proportion of non-contrast enhancing tumor (nCET), and proportion of edema. Univariate cox proportional hazards analysis identified hemorrhage (HR 5.6, 95% CI 1.1-28.2, p=0.035), nCET crossing midline (HR 2.5 95% CI 1.2-5.2, p=0.048), and size (HR 1.15 95% CI 1.01-1.33, p=0.05) as features which increased the hazard for progression. Hierarchical clustering identified 5 patient subgroups with distinctive correlated imaging features and varied survival.

CONCLUSION

VASARI features require refinement in their definition before broad acceptance for pHGG. Some features may be prognostic at diagnosis, and may aid further risk classification beyond classic clinical and pathologic factors.

CLINICAL RELEVANCE/APPLICATION

VASARI features may be prognostic and identify distinct populations in pHGG.

SSQ17-06 Post Treatment DSC-MRI is Predictive of Early Treatment Failure in Children with Supratentorial High-Grade Glioma Treated with Erlotinib

Thursday, Nov. 30 11:20AM - 11:30AM Room: S103CD

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PURPOSE

The role of perfusion imaging in the management of pediatric high grade glioma is unclear. We evaluated the ability of DSC-MRI to determine grade, evaluate post-treatment response and predict treatment failure.

METHOD AND MATERIALS

Twenty-two patients with high-grade glioma underwent biopsy and were treated with concurrent and sequential radiotherapy and erlotinib as part of a phase I/II clinical trial (NCTXXXX). Pre-, immediate post-radiotherapy, 6-month, and treatment failure DSC MR images were reviewed, registered, and processed for the ratio of CBF and CBV. Processed, derived perfusion, and T1WI, T2WI, and FLAIR MRI sequences were used for segmentation and extraction of tumor perfusion parameters at all time-points. Patient, tumor, treatment, and outcome data were summarized and related to perfusion data.

RESULTS

Regional CBF in tumors increased from diagnosis to post radiotherapy, while they decreased to levels below those at diagnosis from post radiotherapy to 6-month follow up. At 6 months, the median regional CBF was higher in tumors that progressed (median, 1.16) than in those that did not (median, 0.95;P< .05). Patients with CBF ratios above 1.4 at diagnosis had shorter survival times relative to CBF ratios below 1.4 (P= .77). Tumors with a regional CBV above 1.15 at the post-radiotherapy (1- to 3-month) follow-up scan were associated with an earlier time to death than that of tumors with a CBV below 1.15 (P< .05).

CONCLUSION

Post-treatment perfusion characteristics are prognostic and may predict survival. Perfusion MRI is useful for managing pediatric high-grade glioma and should be incorporated into future trials.

CLINICAL RELEVANCE/APPLICATION

DSC-MRI is recommended in the evaluation of treatment response in pediatric patients with high grade glioma

SSQ17-07 Differentiation of Medulloblastoma and Astrocytoma in Children Using Histogram Analysis of Enhancement MRI

Thursday, Nov. 30 11:30AM - 11:40AM Room: S103CD

Participants
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PURPOSE

To investigate the diagnostic value of the histogram analysis derived from enhancement MR imaging in differentiating medulloblastomas from astrocytomas.

METHOD AND MATERIALS

Retrospective analysis of 47 patients which were pathologically confirmed posterior fossa tumors, including 29 cases of medulloblastoma,18 cases of astrocytoma.Drawing the region of interest(ROI) on the maximum level of enhanced MR sagittal image and going on histogram analysis,these two steps are all performed on the software named Mazda.Performed a statistical analysis on the histogram parameters to find out the characteristics of the significant differences between the two groups.

RESULTS

In the 9 parameters which are extracted from histogram,C99 has the statistical significance.The maximum area under the ROC curve was 0.85.The optimum C99 to distinguish medulloblastomas from astrocytomas was 176.5(76% specificity and 61% sensitivity).

CONCLUSION

Histogram analysis of enhancement MR imaging can provide reliably objective basis for differentiating medulloblastomas from astrocytomas.

CLINICAL RELEVANCE/APPLICATION

Histogram analysis of enhancement MR imaging is a new method,can provide reliably objective basis for differentiating medulloblastomas from astrocytomas.

SSQ17-08 Diagnostic Accuracy of MRI Perfusion (DSC) to Determine Grades and Types of Pediatric Primary Brain Tumors: A Multiparametric Approach

Thursday, Nov. 30 11:40AM - 11:50AM Room: S103CD

Participants
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PURPOSE

The goal of this prospective study was to assess the diagnostic accuracy of multiple parameters from dynamic susceptibility contrast (DSC) perfusion, in the distinction of pediatric brain tumor grades and types.

METHOD AND MATERIALS

A retrospective blinded review of 53 histologically proven pediatric brain tumors with DSC perfusion was performed independently by two neuroradiologists. Tumors were categorized by grade and by histological. Maximum rCBV (rCBVmax), Percentage Signal Recovery (PSR) and Contrast Leakage Patterns (CLP) were measured from manual ROI placement for each reviewer and averaged. Results from all three analyses were compared to WHO grade and tumors type. Multivariate statistical analysis was performed to evaluate the diagnostic accuracy of single and combined perfusion parameters, and of single parameters to distinguish the different groups.

RESULTS

rCBVmax demonstrated a positive correlation with tumor grade, but limited specificity for tumors type. PSR and CLP demonstrated a positive correlation with tumor type when tumors were grouped by astrocytic and non-astrocytic. The highest diagnostic accuracy for tumor grading and typing was obtained using all three perfusion parameters. Pilocytic astrocytomas demonstrated a peculiar perfusional pattern: rCBV<1.6, high PSR and T1-dominant leak.

CONCLUSION

Multiparametric MR imaging can be accurate in determining tumor grades and types (mainly pilocytic astrocytomas and embryonal tumors) in children.

CLINICAL RELEVANCE/APPLICATION

Perfusion MRI is of utility to increase diagnostic accuracy for adult brain tumor. In pediatric population the heterogeneity of tumors need more than one perfusion parameter to gain an higher sensitivity and specificity for grading and distinguishing brain neoplasms

SSQ17-09 MRI Surrogates of Molecular Subgroups in Pediatric Atypical Teratoid / Rhabdoid Tumor

Thursday, Nov. 30 11:50AM - 12:00PM Room: S103CD

Participants
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PURPOSE

Recent research identified new molecular subgroups in atypical teratoid / rhabdoid tumor (AT/RT). MRI characteristics of AT/RT have not yet been analyzed according to molecular parameters. We aimed to identify morphological features that may help predict molecular subgroups by means of MRI.

METHOD AND MATERIALS

A total of 43 consecutive patients with known molecular subtyping (AT/RT-TYR n=16, -SHH n=17, -MYC n=10) were obtained from the EU-RHAB register. We analyzed epidemiologic and standardized imaging parameters as well as meningeal dissemination status. Statistical analysis between molecular subgroups was performed by Mann-Whitney U test and chi-squared test.

RESULTS

In contrast to distinct origin (supra-/infratentorial, p=.002) of molecular AT/RT subgroups, a midline/off-midline localization was not significantly different. Typical cysts in the tumor periphery were found most frequently in AT/RT-TYR (p=.012). There was a tendency (p=.052) to strong contrast enhancement in AT/RT-TYR and AT/RT-MYC, whereas enhancement was absent in almost one third of -SHH tumors. Patient age and gender as well as tumor volume and visible meningeal dissemination were not significantly different between molecular subgroups.

CONCLUSION

This is the first study that describes and compares MR imaging features according to molecular subgroups in pediatric AT/RT. In contrast to previous studies, we show that an off-midline location is not specific for infratentorial AT/RT. Peripheral cysts and/or a band-like 'wavy" enhancement, if present, are important characteristics to differentiate AT/RT from other tumor entities in children < 3 years of age. These findings could be observed throughout all molecular subgroups, but with different frequencies. Correlation of initial MR imaging features with clinical outcome might be of great interest for individual risk assessment and patient stratification.

CLINICAL RELEVANCE/APPLICATION

Beyond typical anatomical distribution of molecular subgroups, we identified morphological parameters that may help to differentiate pediatric AT/RT with MR imaging.

SSQ18

Physics (Quantitative Image Analysis)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S403B

BQ CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSQ18-01 Feasibility of Multi-Reference-Tissue Normalization of T2-Weighted Prostate MRI

Thursday, Nov. 30 10:30AM - 10:40AM Room: S403B

Participants
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PURPOSE

To explore a novel multi-reference-tissue normalization method applied to t2-weighted prostate MRI.

METHOD AND MATERIALS

Assuming the availability of a set of distinct reference tissue segmentations, the hypothesis is that it allows computing a patient specific sequence model that can normalize MRI. The normalization should produce similar scalar values in the same reference regions for different patients/scanners/sequences and interpolate in between reference values for other tissue areas. Regions of interest (ROI) were drawn in four distinct tissue types in a cohort of sixty-five t2-weighted images from regular multiparametric prostate MRI (mpMRI). The four reference tissue types were: skeletal muscle, body fat, femur head, bladder lumen. Four average ROI signals were computed per patient. Each reference tissue was assigned a fixed reference value (t2 relaxation found in literature). Per patient, a smooth sequence model was fitted to the (average, reference) pairs. The estimated sequence model was then inverted to map patients' raw t2-weighted image scalar values to normalized values. To test the method, the effect of normalization on observed variance and tissue discriminability was analyzed. A leave-one-out experiment was performed in which for each ROI its normalized value was computed using the sequence model estimate using the three remaining reference ROIs. The difference between original t2-weighted and normalized scalar MRI was analyzed by means of variability and ROC analysis.

RESULTS

Multi-reference-tissue normalization significantly ($p<0.05$) decreased variability and increased the area under the ROC curve for discriminating each reference tissue combination. The ROC curves in the figure show the effect of the normalization (T2-n) on the discrimination between body fat and femur head tissue.

CONCLUSION

Semi-automatic multi-reference-tissue normalization shows reduced inter-patient variability and may allow better quantitative discrimination between tissue types.

CLINICAL RELEVANCE/APPLICATION

Multi-reference-tissue t2-weighted MRI normalization seems feasible. In combination with automatic segmentation, this could be providing clinical quantitative imaging support to mpMRI diagnosis of prostate cancer. This result motivates us to continue to explore the ability of this novel method to help detect and discriminate prostate cancer in mpMRI.

SSQ18-02 Automatic Algorithm for Joint Morphology Measurements in Volumetric Musculoskeletal Imaging

Thursday, Nov. 30 10:40AM - 10:50AM Room: S403B

Participants
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PURPOSE

An automated algorithm was developed for measurements of bone morphology and joint alignment in volumetric musculoskeletal imaging. The algorithm was applied to evaluation of the weight-bearing tibiofemoral and patellofemoral joints using a dedicated extremity cone-beam CT (CBCT) system.

METHOD AND MATERIALS

Weight-bearing CBCT scans were acquired from 24 healthy subjects at ~12 mGy dose; reconstructed field of view was 20x20x30 cm3 with 0.56 mm isotropic voxels. Anatomical landmarks on tibia, femur, and patella were set by an expert radiologist for the following metrics: Medial Tibial Depth (MTD), Tibial Tuberosity-Trochlear Groove (TTTG) distance, and Insall-Salvati-Ratio (ISR). The automated algorithm uses three sets of atlas volumes, one for each of the bones. The atlases are annotated with pertinent anatomical landmarks according to expert reader consensus. The atlas volumes are first registered (individually for each bone) to the analyzed volume using Mattes mutual information and similarity transforms. The best fitting atlas images are then selected, and their bone surfaces are deformably registered to the corresponding bones in the analyzed volume. No segmentation of the analyzed volume is necessary. The transforms found in the registration are then applied to the atlas landmarks to compute the anatomical metrics.

RESULTS

The deviation of the anatomical landmarks found by the algorithm from the locations selected by the expert reader are within the range of intra-reader variability (~1 mm). The automated algorithm achieved high level of agreement with expert radiologist readings in leave-one-out evaluation of the anatomical metrics, with ICC of 1.0, 0.93, and 0.97 for TTTG, ISR, and MTD, respectively. The RMSE of the metrics sharply decreases with increasing number of atlas images, achieving RMSE of less than 0.5 mm for TTTG and MTD less than 0.2 [a.u.] for ISR when 15 atlas images are used for each bone.

CONCLUSION

The algorithm achieved high correlation with expert radiologist readings, providing quantitative assessment of the complex, multi-body anatomy of the joints in support of orthopedic diagnosis and surgical planning.

CLINICAL RELEVANCE/APPLICATION

An automatic algorithm for image-based anatomical measurements in musculoskeletal radiology supports quantitative assessment of joint morphology in diagnostic and surgical applications.

SSQ18-03 A Contrast-to-Noise Ratio for Clinical Mammographic Images

Thursday, Nov. 30 10:50AM - 11:00AM Room: S403B

Participants
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PURPOSE

Image quality estimation directly from clinical mammograms rather than from phantom images would allow for patient-specific and 'real-time' monitoring of complete system performance. This study evaluates a novel method to estimate a contrast-to-noise ratio (CNR) directly from mammograms.

METHOD AND MATERIALS

The novel CNR uses a noise estimation from the compressed breast region that minimizes the influence tissue characteristics, while a signal difference between pixels with known tissue compositions serves as an alternative to the difference between a phantom contrast feature and uniform background. For initial validation, a phantom with 0.2 mm Al and 2-8 cm PMMA was imaged with technique factors to match automatic exposure control (AEC)-acquisition on the GE Senographe Essential, and in combo-mode (FFDM & DBT) on the Hologic Selenia Dimensions. CNR measured from phantom images per EUREF guidelines was compared to CNR determined using noise estimated by the proposed method. The novel CNR was calculated for AEC-acquired clinical images and plotted against compressed thickness following typical analysis of AEC performance. The dataset included 274 Hologic Selenia Dimensions combo-mode images and 80 GE Senographe Essential FFDM images. Phantom and clinical images were acquired on different machines. Version 1.5.3.0 of the VolparaDensity algorithm was applied to measure tissue composition.

RESULTS

The correlation was excellent between the EUREF-derived and novel CNR for phantom images, with Pearson coefficients over 0.99. The trends between mammographic image CNR and thickness correspond well to the phantom-verified relationships, with differences in phantom and mammographic CNR magnitudes largely resulting from the different contrast materials and methodologies, along with some variability from machine-specific performance.

CONCLUSION

A novel CNR measure was assessed using phantom and clinical mammographic images. The validation results show promise for the ability to avoid signal variations due to tissue structure, while extracting system-dependent data to make objective CNR estimates. Future work will assess clinical image CNR sensitivity to variations in acquisition parameters.

CLINICAL RELEVANCE/APPLICATION

To our knowledge this is the first description of an objective CNR measure that can be made directly from mammographic images, thereby enabling real-time and patient-specific image quality evaluation.

SSQ18-04 Framework for Automatic 3D Coronary Artery Vessel Wall Segmentation from Coronary CT Angiography

Thursday, Nov. 30 11:00AM - 11:10AM Room: S403B

Participants
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PURPOSE

To develop a framework for automated 3D segmentation of the coronary vessel wall and atherosclerotic plaque in the three major coronary artery vessels using level sets and centerline as a guide. To overcome premature termination of coronary segmentation caused by poor contrast, motion artifacts, and severe stenosis.

METHOD AND MATERIALS

The proposed framework computes the vesselness and, with the original 3D coronary image, obtains an initial lumen contour via region growing. Next, a level set energy function is minimized to segment the lumen boundaries. Subsequently, the segmented lumen is utilized as the initial vessel outer boundaries. A second level set energy function segments the final outer wall using a specific sigmoid feature image. The lumen and vessel boundaries are joined to create the coronary wall. Once the wall is segmented, curved multiplanar reformation is used to straighten the segmented lumen and wall using the lumen centerline. Coronary CTA data were acquired from 41 asymptomatic CAD subjects. Images were read by a radiologist to identify the segments of adequate diagnostic image quality and the extent of atherosclerosis plaque burden therein including plaque presence, type, volume, and luminal stenosis severity. Wall and plaque volumes were segmented using the framework and compared to an expert radiologist's manual delineation. The evaluation dataset contained 122 plaques of different characteristics.

RESULTS

Agreement between automatic and radiologist segmentation improved was a function of plaque. For small, mild, medium, and large plaques, mean±SD similarity DICE coefficient between segmented and radiologist's delineation was 86±13%, 90±10%, 95±5%, and 95±6%, respectively. Relative volume difference was 7.3±7.3%, 5.2±5.2%, 4.9±3.9%, and 4.1±5.4%, respectively. The p-values from a paired t-test comparing the radiologist to framework segmentation volumes were $p=0.72$ for small, $p=0.76$ for mild, $p=0.89$ for medium, and $p<<0.93$ for large plaques.

CONCLUSION

Automatic CTA coronary wall segmentation that is highly similar to radiologist's manual delineation is feasible, which thus is promising for accelerated, reliable, and reproducible atherosclerotic plaque characterization.

CLINICAL RELEVANCE/APPLICATION

Automatic segmentation of CTA coronary wall improves objective quantification of coronary atherosclerotic plaque beyond subjective assessment of stenosis and potentially applicable for monitoring response to therapy.

SSQ18-05 CT Coronary Calcium Scoring with Tin Filtration Using Iterative Beam-Hardening Calcium Correction Reconstruction

Thursday, Nov. 30 11:10AM - 11:20AM Room: S403B

Participants
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PURPOSE

To investigate the diagnostic accuracy of CT coronary artery calcium scoring (CACS) with tin pre-filtration (Sn100kVp) using

To investigate the diagnostic accuracy of CT coronary artery calcium scoring (CACS) with tin pre-filtration (Sn100kVp) using iterative beam-hardening correction (IBHC) calcium material reconstruction compared to the standard 120kVp acquisition.

METHOD AND MATERIALS

In an IRB-approved, HIPAA compliant prospective study, 62 patients (56% male, age 63.9±9.2years) underwent a clinically-indicated CACS acquisition using the standard 120kVp protocol and an additional Sn100kVp CACS research scan. Datasets of the Sn100kVp scans were reconstructed using a dedicated spectral IBHC CACS reconstruction to restore the spectral response of 120kVp spectra. Agatston scores were derived from 120kVp and IBHC reconstructed Sn100kVp studies. Pearson`s correlation coefficient was assessed and Agatston score categories and percentile-based risk categorization were compared.

CONCLUSION

Low voltage CACS with tin filtration using a dedicated IBHC CACS material reconstruction algorithm shows excellent correlation and agreement with the standard 120kVp acquisition regarding Agatston score and cardiac risk categorization, while radiation dose is significantly reduced by 75% to the level of a chest x-ray.

CLINICAL RELEVANCE/APPLICATION

Low x-ray tube voltage third generation dual-source CT CACS paired with tin pre-filtration and iterative beam-hardening correction calcium material reconstruction allows for coronary artery calcium quantification in excellent correlation with standard protocols, albeit at a fraction of the radiation dose. This approach thus seems well suited for a screening test in a priori healthy individuals.

SSQ18-06 Robustness Evaluation of RA-950 Scoring in a Cohort of CT Lung Screening Patients Across a Large Range of CT Acquisition and Reconstruction Conditions

Thursday, Nov. 30 11:20AM - 11:30AM Room: S403B

Participants
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PURPOSE

Interest in quantitative evaluation of images is high, however variation in imaging protocols raises questions about the reliability of utilized metrics. In this study we investigate the multivariate effects of CT acquisition and reconstruction parameters on emphysema scoring in CT lung screening.

METHOD AND MATERIALS

30 clinical lung screening scans were selected from an in-house archive that contains raw projection data. Reduced dose acquisitions were simulated at 50%, 10%, and 5% of clinical dose (~2mGy CTDIvol) by adding noise to the raw data. Full-dose and reduced-dose acquisitions were then reconstructed using the open-source software "FreeCT_wFBP" at slice thicknesses of 0.6, 1, 2, and 5mm using smooth, medium and sharp kernels for a total of 48 reconstructions per patient. To score emphysema, a density mask was applied with -950HU as the threshold (RA-950 score), and for each parameter configuration, change in RA-950 relative to a reference (100% dose, 1.0mm slice thickness, medium kernel; chosen for similarity to clinical protocols) was calculated and averaged across the population.

RESULTS

Only 21 of 48 (44%) configurations produced scores within ±5% of the reference suggesting limitations to the range of acceptable parameters for quantitative emphysema evaluation. Configurations using the sharp kernel, the 0.6 mm slice thickness, or doses below 50% of the clinical reference consistently produced scores very different than reference. Protocols producing higher image noise resulted in higher RA-950 scores. With slice thicknesses >=1.0mm and the smooth or medium kernel, the 50% dose configuration results in RA-950 comparable to reference. Patient-specific surface plots revealed that change in RA-950 as a function of reconstruction parameter strongly depends on the amount of emphysema measured at reference.

CONCLUSION

As quantitative evaluation of COPD increases and efforts to reduce CT dose continue, changes in protocol are likely. This study shows that reliable quantitative emphysema evaluation is possible with further dose reduction (to ~1mGy) when combined with appropriate reconstruction parameters, however care must be taken to prevent parameter-dependent changes in the measured score.

CLINICAL RELEVANCE/APPLICATION

Establishing protocols for reliable quantitative metrics is critical for the use of clinical quantitative imaging. This study assesses and provides guidance on RA-950 scoring for the evaluation of emphysema.

SSQ18-07 Fully Automatic Measurement of the Splenic Volume in CT with U-Net Convolutional Neural Networks

Thursday, Nov. 30 11:30AM - 11:40AM Room: S403B

Participants
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PURPOSE

To develop a fully automatic deep learning method for 3D segmentation of the spleen on computed tomography (CT) scans and to compare the automatically measured spleen volume with the standard splenic index approximation formula that requires three 2D manual measurements.

METHOD AND MATERIALS

145 CT thorax-abdomen scans were collected from our institute. All scans were contrast enhanced and acquired with a slice thickness of 1 or 2 mm. The spleens were manually segmented in 3D by trained human observers in all scans. We used 100 scans for training and 45 scans as an independent test set. In the test set, the standard approximation formula was applied by a human observer to get an estimation of the splenic volume. The system fully analyzes the entire thorax-abdomen CT scan to segment the exact location of the spleen, without any need for pre-processing. Multiple U-net convolutional neural networks were trained for different orthogonal directions using the training data set. A validation set consisting of 30% of the training data was used to optimize the hyperparameters of the neural network. A dedicated hard mining selection strategy was employed to improve the learning process. The predictions of the U-nets were averaged and subsequently thresholded to obtain a 3D spleen segmentation. The mean absolute error of the splenic volume was used to measure the accuracy of the deep learning approach and the standard approximation formula in comparison to the manual reference standard. The performance of the deep learning approach was also evaluated by computing the Dice similarity coefficient on the test set.

RESULTS

The deep learning approach resulted in a mean absolute error of 8.5% (SD 11.6) in the splenic volume while the approximation formula gave a significantly higher ($p<0.01$) mean absolute error of 17.7% (SD 14.7). The average Dice score between the deep learning segmentations and the reference segmentations was 0.91 (SD 0.08).

CONCLUSION

Splenic volume can be fully automatically assessed using a U-net deep learning approach, with an accuracy that is substantially better than the clinically widely used approximation formula.

CLINICAL RELEVANCE/APPLICATION

An accurate splenic volume measurement can be used for assessing splenomegaly and for detecting changes in splenic volume over time.

SSQ18-08 Newly Developed 3D Computer-Aided Volumetry (CADv) with Pulmonary Nodule Component Evaluation: Capability for Quantitative Prediction of Malignancy and Postoperative Recurrence on Thin-Section CT

Thursday, Nov. 30 11:40AM - 11:50AM Room: S403B

Participants
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PURPOSE

To evaluate the quantitative capability of newly developed 3D computer-aided volumetry (CADv) with pulmonary nodule component assessment for predicting malignancy and postoperative recurrence on thin-section CT.

METHOD AND MATERIALS

59 consecutive patients with 101 pulmonary nodules underwent repeated thin-section CT, pathological examination, surgical resection and/ or follow-up examination. Then, all nodules were divided into malignant (n=64) and benign (n=37) nodule groups. In addition, all patients with operated as malignancy were also divided into postoperative recurrence (n=12) and non-recurrence (n=53) groups. In this study, CADv automatically assessed solid, ground-glass opacity, cavity and total nodule volumes from two serial CT data. Then, total volume change per day (TV/day), solid to total volume change ratio per day (S/T ratio/day) and doubling time (DT) were determined. Student's t-test was performed to compare all indexes between malignant and benign groups, and between recurrence and non-recurrence groups. Then, ROC analyses were performed to compare differentiation capabilities of indexes as having significant differences between malignant and benign groups, and between recurrence and non-recurrence groups. Finally, each diagnostic performances was compared by McNemar's test.

RESULTS

TV/day and DT had significant differences between malignant and benign nodule groups ($p<0.05$), although TV/day and S/T ratio/day had significant difference between recurrence and non-recurrence groups ($p<0.05$). On distinguishing malignant from benign groups, area under the curves (Azs) of TV/day (Az=0.94) was significantly larger than that of DT (Az=0.62, $p<0.001$). In addition, specificity (SP) and accuracy (AC) of TV/day were significantly higher than those of DT ($p<0.001$). For distinguishing recurrence from non-recurrence groups, Az of S/T ratio/day (Az=0.92) was significantly larger than that of TV/day (Az=0.68, $p=0.006$). Moreover, SP and AC of S/T ratio/day were significantly higher than those of TV/day ($p<0.001$).

CONCLUSION

Newly developed 3D CADv system has quantitative capability for prediction of malignancy and postoperative recurrence on thin-section CT.

CLINICAL RELEVANCE/APPLICATION

Newly developed 3D CADv system has quantitative capability for prediction of malignancy and postoperative recurrence on thin-section CT.

SSQ18-09 Quantitative Evaluation of Partial Obstruction of the Upper Urinary Tract by Analyzing Sequential Fluoroscopic Images from Antegrade Nephrostograms

Thursday, Nov. 30 11:50AM - 12:00PM Room: S403B

Participants
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PURPOSE

Visual monitoring of fluoroscopy images, following PCNL does not allow for objective assessment of partial obstruction in the upper urinary tract. This study describes an algorithm for a quantitative evaluation of the urine flow rate, by analyzing sequential images from a routine nephrostogram.

METHOD AND MATERIALS

Following PCNL, contrast agent is introduced into the renal collecting system and serial fluoroscopic images of the renal pelvis are visually evaluated to ensure that contrast material is drained through the upper urinary tract. This study examined fluoroscopic images obtained retrospectively from nephrostograms of 40 subjects, 3 days following PCNL. In 16 cases, visual estimation of the images indicated partial obstruction. An algorithm was developed to calculate the amount of contrast agent in the renal pelvis, in each sequential image, by analyzing the integrated gray level values. As the contrast material is drained, its radio-opacity is decreased. The amount of contrast material in each image was calculated as a function of time, to yield a clearance curve of the contrast material from the renal pelvis. From this curve, the urine flow rate in the renal collecting system was calculated.

RESULTS

For each of the 40 cases, the obtained clearance curve highly fitted an exponential regression function with a mean correlation coefficient of 0.96 . The time constant - τ of the exponential decay was automatically calculated for each case. From the known value of τ, the time $t_{1/2}$ at which half of the contrast agent has drained from the renal pelvis was calculated. The mean value of $t_{1/2}$ for the 16 cases with suspected partial obstruction was 9.1 minutes, while for the 24 cases without suspected obstruction it was 2.4 minutes. The difference between the $t_{1/2}$ value of the two groups was statistically significant ($p<0.05$).

CONCLUSION

The described algorithm provides a quantitative assessment for the urine flow rate in the renal collecting system. The calculated time at which half of the contrast agent has drained from the renal pelvis following PCNL, was significantly longer in cases with partial obstruction.

CLINICAL RELEVANCE/APPLICATION

Measuring urine flow rate by processing fluoroscopic images from a routine nephrostogram examination may be used for diagnosing and quantitatively assessing partial obstruction in the upper urinary tract. This early diagnosis will improve patient care and management.

SSQ19

Physics (CT, Tomosynthesis, Fluoroscopy)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S404AB

CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credits: 1.50

FDA Discussions may include off-label uses.

Participants
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Charles E. Willis, PhD, Houston, TX (*Moderator*) Medical Advisory Board, General Electric Company

Sub-Events

SSQ19-01 First-Reader Computerized System for Distinction between Malignant and Benign Nodules on Thoracic CT Images By Means of End-To-End Deep Learning: Convolutional Neural Network (CNN) and Neural Network Convolution (NNC) Approaches

Thursday, Nov. 30 10:30AM - 10:40AM Room: S404AB

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PURPOSE

Existing computer-aided detection (CADe) systems have not reached high enough sensitivity to be used as a first reader. In the computer vision field, deep learning achieved overwhelming success with substantially higher performance than existing methods. Our purpose was to develop a first-reader CADe system for distinguishing benign from malignant lung nodules in CT by using deep-learning models, namely, a CNN and our original NNC.

METHOD AND MATERIALS

We developed a CNN with 5 layers: 2 convolution layers and a pooling layer followed by a fully-connected soft-max layer, and NNC consisting of neural network regression (NNR) with 3 layers followed by a scoring layer. In NNC, convolution of the NNR was performed to process the entire 3D volume, but unlike CNN it was done outside the network. The NNC was trained with input volumes containing nodules and "teaching" maps for probability of malignancy. Namely, the desired output volumes for malignant and benign nodules contained a 3D Gaussian distribution and completely dark, respectively. Thus, the NNC was trained to enhance malignant nodules. To obtain a likelihood of malignancy, Gaussian weighting was performed on the output volume in the scoring layer. To test those 2 deep-learning models, we collected 94 lung nodules (34 malignant; 60 benign) from the LIDC-IDRI database. The malignancy and benignancy of the nodules were determined by 3 radiologists. The CT had slice thickness ranging from 0.5-3.0 mm. Tube voltage and current range from 120-140 kVp and 40-570 mA, respectively. We performed a two-fold cross-validation test. Receiver-operating-characteristic (ROC) analysis was used for evaluating the performance.

RESULTS

Our NNC achieved an area-under-the ROC curve (AUC) of 0.997, whereas the CNN achieved 0.986 (p=.083). Our NNC distinguished all malignant nodules correctly from 54 out of 60 benign nodules (10% false positive (FP) rate).

CONCLUSION

Our NNC classified 100% of malignant lung nodules correctly with 10% of FPs in CT. Our system could be used as a first reader where radiologists only check the cases suggested by our "screening" system.

CLINICAL RELEVANCE/APPLICATION

Our high-performance deep-learning-based system would reduce radiologists' workload thus improve the efficiency and potentially improve their diagnostic performance.

SSQ19-02 Development of a New Phantom to Measure Image Quality for Iterative Reconstruction in CT for Abdominal Scanning

Thursday, Nov. 30 10:40AM - 10:50AM Room: S404AB

Participants

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PURPOSE

To develop a novel phantom for abdominal CT image quality measurements feasible for iterative reconstructions.

METHOD AND MATERIALS

An anthropomorphic abdominal phantom, designed for ROC studies and quantitative image quality analyses was tested. The phantom consisted of 4 ROC inserts, one MTF insert, and two iodine test inserts. The iodine inserts contained 6 lesions of different sizes and density (1g and 5 g of iodine). The MTF insert contained two tungsten carbide beads. The ROC inserts contained 12 lesions (16 HU contrast to background difference). The phantom was scanned on Siemens Drive. The four ROC inserts were rotated and interchanged between scans. Scan parameters: 120 kVp, CTDIvol 10, 15 and 20 mGy, 3 mm slices, FBP B30f, Admire 2 and Admire 3 reconstructions. Three readers evaluated all images in a blinded, randomized order upon a 5 point scale, and area under curve (auc) was calculated. MTF, SNR and CNR were measured for all reconstructions and all dose levels, using ImageOwl. Spearman's rank correlation coefficient was used for evaluation of correlation between different image quality measurements.

RESULTS

For all dose levels, the iterative reconstruction techniques, Admire, had higher MTF and improved lesion detectability (significant for 10 and 15 mGy, derived from ROC studies) compared to FBP. Admire 3 had the highest score and FBP the lowest score for CNR and SNR for all dose levels. The Spearman's rank correlation coefficients for the correlation between auc and MTF, SNR and CNR were 0.26 (p=0.497), 0.81 (p=0.011) and 0.92 (p=0.001) respectively. The results indicate a strong correlation beween ROC lesion detectability and SNR and CNR. The correlation between lesion detectability and MTF was not significant.

CONCLUSION

The new phantom enabled a combination of quantitative and qualitative image quality measurements important for optimization of image quality for CT examinations. The correlation between the lesion detectability and SNR and CNR was good, indicating that both quantiative and qualitative measurements give meaningful results for both FBP and the iterative reconstruction, Admire, for abdominal CT.

CLINICAL RELEVANCE/APPLICATION

Optimization of iterative reconstruction demand phantoms designed for qualitive and quantiative image quality analysis. A new abdominal phantom designed for ROC studies showed promising results.

SSQ19-03 Motion Compensated CT Imaging of the Aortic Valve

Thursday, Nov. 30 10:50AM - 11:00AM Room: S404AB

Participants
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PURPOSE

Cardiac CT imaging is used for the planning of transcatheter aortic valve implantation (TAVI). ECG correlated data acquisition and gated reconstruction enables imaging of the valve in the systolic and diastolic phase. Especially in the systolic phase, motion artifacts may occur and interfere with diagnosis and treatment planning. The purpose of the study was to analyze the efficiency of a second pass motion correction method to compensate cardiac motion.

METHOD AND MATERIALS

A time series of cardiac contrast enhanced CT volume images were first reconstructed atdifferent phase points with a temporal distance of 5% cardiac cycle. Edge features of the valve, thevalve leaflets and the neighboring vascular anatomy were enhanced in the reconstructed images by agradient based filter which uses non-maximum-suppression and hysteresis thresholding. Afterwards, a subsequent elastic image registration was applied to estimate dense motion vector fields for thedifferent cardiac phases. The resulting motion vector fields are included in the motion compensatedfiltered back projection and interpolated in the time domain to cover the temporal projection rangerequired for reconstruction. The method was applied to retrospective ECG-gated clinical datasetsacquired with a 256-slice CT scanner (Brilliance iCT, Philips Healthcare) and tested for systolic (30%R-R-interval) and diastolic (70%) imaging of the valve on ten data sets.

RESULTS

The method achieved motion artifact reduction in both heart phases. Especially in late systolea strong improvement in image quality and visibility of the valve leaflets and aortic boundaries couldbe observed, as well as reduced blurring compared to the gated reconstructions.

CONCLUSION

Motion compensated reconstruction of the aortic valve is feasible using edge filtering andimage based registration for motion estimation. Improved CT image quality and reduced motionartifact levels can be achieved thereby facilitating improved visualization

of the aorta as well asimproved planning and device selection for TAVI procedures.

CLINICAL RELEVANCE/APPLICATION

Improved CT visualization of the aorta by new image processing tools is crucial for optimized planning and device selection for TAVI procedures.

SSQ19-04 Body Position's Effect on the Subclavian Vein Artifact in Carotid Artery CT Angiography: Lateral Position vs Supine Position

Thursday, Nov. 30 11:00AM - 11:10AM Room: S404AB

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PURPOSE

Aim of this study was to assess the body position's effect on the subclavian vein artifact in carotid artery CT angiography by comparing lateral position with supine position.

METHOD AND MATERIALS

80 patients who underwent carotid artery CT angiography imaging were randomly separated into two groups: group A with patient lying with lateral position and B with patient lying with supine position (n=40 for both groups). The other scanning parameters were the same for both groups, including tube voltage of 120kV, tube current of 260mA, pitch of 1.375:1, slice thickness of 5.0mm, large FOV. 70ml contrast agent (omnipaque, 350mgI/ml), 4.0ml/s of flow rate and smart contrast agent monitoring with a threshold of 200Hu were used for both groups. Image noise and CT value of subclavian artery (at the level of subclavian artery origin, vertebral artery origin and subscapular artery origin) and adjacent muscle (trapezius) were measured. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) for subclavian artery were calculated, according the formulas: SNR=CTartery/SD and CNR=(CTartery-CTmuscle)/SD. Subjective image quality was evaluated by two radiologists with a 5-point scale. Measurement data was compared with independent student T test, the image quality score was compared with Mann-Whitney U test.

RESULTS

The SD of group A were lower than that of group B (35.03±14.09 vs 208.21±35.78, $p<0.05$). The SNR and CNR of group A were both higher than those of group B (SNR, 14.19±4.30 vs 6.40±2.3; CNR,10.76±3.62 vs 4.86±1.88, both$p<0.05$). The subjective image quality was also higher in group A than group B (4.30±0.47 vs 3.17±0.70, $p<0.05$).

CONCLUSION

Changed velocity vector of flowing blood via changed body position, could removed the subclavian vein artifacts during carotid artery CT angiography imaging. This technique is useful and very feasible.

CLINICAL RELEVANCE/APPLICATION

Through changed body position to changed velocity vector of flowing blood is a useful and very feasible way to removed the subclavian vein artifacts during carotid artery CT angiography imaging.

SSQ19-05 The Visibility of Peripheral Pulmonary Arteries in Pulmonary Embolism Patients by Free-breathing Combined with High-threshold Bolus Triggering Technique in CT Pulmonary Angiography

Thursday, Nov. 30 11:10AM - 11:20AM Room: S404AB

Participants
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PURPOSE

To investigate the visibility of peripheral pulmonary by computed tomography pulmonary angiography (CTPA) under free breathing mode and to explore the feasibility of this technique in pulmonary embolism patients who can't hold breathing.

METHOD AND MATERIALS

200 patients who were suspected PE underwent CTPA on GE Revolution CT. They were randomly assigned into two groups: free-breathing group (n=100) and breath-holding group (n=100). CTPA were performed with pitch 0.992:1, rotation time 0.28s and 16cm-detector. Automatic bolus-tracking was used with a monitor ROI placed on main pulmonary artery(MPA). For the free-breathing group, scan started immediately as the CT value reached a 250 HU threshold; for the breath-holding group, scan started 5 seconds after reaching an 80 HU threshold. The reconstruction slice thickness and interval were 0.625 mm with standard lung

algorithm and all images were transferred to the ADW 4.6 workstation for diagnosis and evaluation. Mean scanning time was recorded and analyzed by independent-sample t-test; the displayed distal branches of pulmonary artery was recorded and chi-square test was used for statistical analysis.

RESULTS

All CTPA were performed successfully and all the farthest branches reached of 6 or farer. There was no significant difference between the two groups in mean scanning time(0.67±0.09s vs 0.67s±0.10s, p=0.367). The order of distal pulmonary arteries of 6, 7 and 8 in the free and holding groups were 25, 57, 18 vs 17, 61, 22 respectively.There was no significant difference between the two groups ($\chi 2=2.059$, p=0.357), and there was no significant statistical significance ($p > 0.5$).

CONCLUSION

Compared with breath-holding mode, the free breathing mode CTPA by 16cm-wide detector scanner has the same ability to display the peripheral pulmonary arteries.

CLINICAL RELEVANCE/APPLICATION

Free breathing CTPA can be successfully applied in PE patients, especially valuable for the patients who can't hold their breath.

SSQ19-06 Patient Dose Reduction in Tomosynthesis Imaging: Application of a New Computerized Reconstruction Technique

Thursday, Nov. 30 11:20AM - 11:30AM Room: S404AB

Participants
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PURPOSE

A high radiation dose is one of the problem in tomosynthesis examination. Generally, an increase in the number of projected images results in high image quality of reconstructed tomosynthesis images, but also increases the patient dose. In this study, we developed a new interpolation technique for improving the image quality of reconstructed tomosynthesis images with a reduced number of projection images.

METHOD AND MATERIALS

A full projected images (73 projections) were acquired with Safire17 (Shimadzu Co.) as the original data set (Orig-set). Partially projected image data sets (Sub-set) with 37, 19, and 11 projections were selected from the Orig-set with intervals of 1, 3, and 7 projections. In this study, the Path Framework (PF) method, which was originally developed for a video interpolation technique, was applied to interpolate interval projection images of Sub-set images. The pixel value of the interpolated image was estimated from one of the two input images before and after the target phase; this pixel value was determined using the shifted value between the target phase and the two input images. Using this technique, the frequency content of the original image could be preserved without blurring. Three image data sets with 73 projection images were consisted with real projection images and their interpolated projection images obtained by the PF method (PF-set). Tomosynthesis images were reconstructed by these data sets using filtered back-projection. In order to evaluate the image quality, we adopted the wire method and the two-dimensional fast Fourier transformation method for spatial resolution and noise property, respectively.

RESULTS

Spatial resolution and noise property of tomosynthesis images reconstructed from the PF-set were equivalent to those obtained from the Orig-set., whereas the spatial resolution of tomosynthesis images was clearly degraded by using a conventional interpolation technique.

CONCLUSION

The number of projected images can be reduced more than 50% by using the PF method without degradation of image quality. We believe this proposed method would be utilized for the reduction of patient dose in tomosynthesis.

CLINICAL RELEVANCE/APPLICATION

This proposed method would be applied for various tomosynthesis systems without any modification of system hardware and can realize patient dose reduction effectively.

SSQ19-07 Ex-Vivo Neuro-Imaging of Human and Animal Spinal Cords via X-Ray Phase Contrast CT: Detection of Full Organ Anatomy, Micro-Vessels and Single Motor Neurons

Thursday, Nov. 30 11:30AM - 11:40AM Room: S404AB

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PURPOSE

Achieving non-invasively both full-organ visualization and cellular-resolution in the imaging of anatomical and pathological CNS tissue structure is beyond both current clinical and preclinical cutting-edge neuroimaging techniques. In fact, the study of vascular and neurodegenerative disorders still relies heavily on sample-invasive imaging protocols, which involve dissections, staining or labeling of nervous tissue, and which in most cases fail to capture complete volumetric information on cell populations and microvasculature within a full-organ sample. In this ex-vivo study, we used a staining- and dissection-free imaging technique, X-ray phase contrast tomography (PCI-CT), to visualize full-organ vascularization and concurrent detection of single neuronal cells in excised spinal cord samples from both human donors and animals.

METHOD AND MATERIALS

Lumbar spinal cord samples, extracted from both healthy rats and human donors, were imaged using a synchrotron PCI-CT setup. We used 20-40 keV monochromatic coherent X-rays, a sCMOS-sensor PCO camera and an optics system with isometric voxels of sizes from 46^3 micron^3 down to 0.3^3 micron^3.

RESULTS

PCI allowed recognition and differentiation of full-organ spinal cord anatomy, including anterior/posterior gray horns, the dorsal/ventral roots and ganglions, the central canal and the meninges. Superficial as well as deep vessel architecture could be extracted without the need of any contrast-agent. Moreover, at the highest resolutions used, single neuronal cells perfused by surrounding vasculature could be recognized: distinct bundles of nerve fibers, single motor neurons and neuro-glial cells, cell bodies and axons, as well as intra-cellular structure (cell nuclei and nucleoli) were successfully detected.

CONCLUSION

CNS PCI micro-CT, with the unique detection of single cells and of single micro-vessels within full-organ samples, enables a volumetric histology-like analysis of neuronal cell populations and micro-vascular networks in extracted spinal cord samples of both human donors and animals.

CLINICAL RELEVANCE/APPLICATION

Non-invasive visualizations of full-organ CNS micro-vascularization and of neuronal cell populations are fundamental in the preclinical study of vascular and neurodegenerative diseases.

SSQ19-08 Evaluation of a New Nonrigid-Registration Method Using Non-Local Spatio-Temporal Priors on Liver Perfusion CT in Patients with Hepatic Cellular Carcinoma

Thursday, Nov. 30 11:40AM - 11:50AM Room: S404AB

Participants
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PURPOSE

To evaluate the feasibility of the Nonrigid-registration method on free-breathing liver CT perfusion in comparison with standard Rigid-registration method.

METHOD AND MATERIALS

Six studies of three patients with hepatic cellular carcinoma underwent free-breathing liver CT perfusion scanning by using a 128-row CT scanner (Revolution CT, GE Healthcare, Milwaukee, WI). The original axial CT images of all studies were registered by Nonrigid-registration method using Non-local Spatio-temporal Priors (GE Healthcare, Milwaukee, WI) and standard Rigid-registration method (ANALYZE software supplied by Mayo Clinic, Rochester, MN) respectively. The CT perfusion maps (BF, BV, MTT, PS, HAF, HAP and PVP) and motion in tumor regions on images registered by Nonrigid-registration and Rigid-registration were compared.

RESULTS

The Nonrigid-registration method significantly reduced respiratory motion on whole liver region, whereas only focused tumor region can be registered well by using standard Rigid-registration in our study. All the perfusion parameters had no statistically difference between Nonrigid-registration and Rigid-registration (all P values > .05)

CONCLUSION

The new Nonrigid-registration method using Non-local Spatio-temporal Priors gained better alignment on whole liver region than Rigid-registration. The Nonrigid-registration method promotes the application of free-breathing liver CT perfusion in clinical practice.

CLINICAL RELEVANCE/APPLICATION

Nonrigid-registration with non-local spatio-temporal can achieve a stable perfusion CT data and is a powerful method as a first step for image post-processing after CT perfusion scanning.

SSQ19-09 Improved Visibility of Guidewires and Devices for Interventional X-Ray Procedures Using a New Approach to Automatic Exposure Control

Thursday, Nov. 30 11:50AM - 12:00PM Room: S404AB

Participants
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PURPOSE

Current automatic exposure controls (AEC) of fluoroscopy systems adjust acquisition parameters to achieve a constant signal level in the image receptor. This study investigates a new AEC approach that sets parameters which optimize the visibility of specific materials quantified using a figure of merit (FOM). The clinical motivation is to increase efficiency and clinical outcomes in the angio suite while reducing dose.

METHOD AND MATERIALS

A Siemens Artis Q interventional system was used to image a phantom composed of 4, 8 and 12 composite plates, each of 20mm PMMA and 2mm Al, approximating the attenuation of 10, 20 and 30cm human tissue. Seven materials were studied, including iron, iodine contrast and platinum, covering a range of clinically relevant devices and contrast media. Samples were placed at the phantom center and imaged using a new AEC approach based on an FOM composed of a spatial frequency dependent signal difference to noise ratio (SDNR(u)). Standard SDNR was corrected for the influence of focal spot size and object motion blurring by multiplying with MTF based correction factors, which were calculated with access to unprocessed data. The FOM was defined as $SDNR^2(u)$/entrance air kerma rate. The FOM was measured for all samples using a total of 10 new AEC regulation curves, each optimized for a specific material, and the current standard curve. The FOM of the curve matching the correct insert was then compared to the FOM data of the other curves: taking the ratio gave an estimate of the efficiency change.

RESULTS

The new AEC improved the imaging efficiency of metals such as iron, tantalum and platinum: for the 20cm phantom the FOM increased by 16%, 165% and 164% respectively compared to the conventional AEC. There was little or no gain for the 30cm phantom, with increases of 0%, 7% and 4%, respectively, due to restricted parameter selection at large patient thicknesses. The FOM for iodine contrast increased between 15% and 20%, for the 20cm phantom.

CONCLUSION

The new AEC approach shows great potential for increasing the imaging efficiency of a wide range of materials. For a typical patient thickness of 20cm, increases between 15% and 165% were seen compared to the conventional AEC.

CLINICAL RELEVANCE/APPLICATION

Selecting AEC factors by optimizing an FOM instead of keeping X-ray detector signal constant can increase visibility of devices, guidewires and contrast media used during interventional procedures.

SSQ20

Vascular Interventional (Ablation)

Thursday, Nov. 30 10:30AM - 12:00PM Room: N227B

IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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James T. Bui, MD, Chicago, IL (*Moderator*) Nothing to Disclose

Sub-Events

SSQ20-01 Cone Beam CT Guided Irreversible Electroporation (IRE) Probe Placement in a Liver Phantom Using a Preclinical Robotic Navigation System

Thursday, Nov. 30 10:30AM - 10:40AM Room: N227B

Participants
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PURPOSE

To evaluate a robotic assistance device for cone beam CT guided IRE probe placement in a liver phantom with regard to ability of parallel probe placement, precision and intervention time.

METHOD AND MATERIALS

16 IRE probes, covering eight lesions, were placed in a liver phantom (CIRS liver phantom 71a) using a preclinical robotic assistance device and a multi axis c-arm system. Cone beam CT was performed for intervention planning and probe position verification.

RESULTS

Parallel probe placement was achieved in all eight cases. Mean angular deviation of the needle pair was only 1.52°(±0.65°). The mean distance delta (planned distance- actual distance) of the needle pairs was only 1.05mm (±1.65mm). Mean intervention time including planning scan, needle path planning, needle placement and verification scan was 10 min 41s (± 1min 27s).

CONCLUSION

Our preclinical data shows that IRE probes can be placed precisely within an acceptable time when cone beam CT and robotic assistance is used.

CLINICAL RELEVANCE/APPLICATION

Precise and time efficient IRE probe placement is possible when combining cone beam CT and robotic assistance. This approach has great potential to expand the spectrum of possible hybrid interventions and therapeutic strategies.

SSQ20-02 Utility of the 2015 American Thyroid Association (ATA) Guidelines for the Prediction of Clinically Significant Thyroid Cancer: A Review of 1,947 Consecutive Thyroid Biopsies

Thursday, Nov. 30 10:40AM - 10:50AM Room: N227B

Participants
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PURPOSE

To determine if the 2015 American Thyroid Association (ATA) Guidelines effectively stratify the risk of clinically significant thyroid cancer

METHOD AND MATERIALS

We retrospectively reviewed 1947 thyroid nodules which underwent us guided Fine needle aspiration from Oct 2009 to Feb 2016 Each nodule was assigned an ATA category based on sonographic features Each pt underwent a dedicated thyroid US and US guided fine needle aspiration performed by our cross-sectional interventional team

RESULTS

We aspirated 14 category 1 lesions which have a < 1% risk of malignancy. These are thyroid cysts. None of these were found to be malignant. We aspirated 249 category 2 lesions which have a < 3% risk of malignancy. These are described as spongiform or partially cystic lesions. One malignancy was associated with each of these appearances We had 733 ATA category 3 lesions which have a 5-10% risk of malignancy. These can be described as hyperechoic nodules, isoechoic solid nodules with regular margin partially cystic with eccentric solid nodule or partially cystic with peripheral nodules. Zero to up to 2% of cancers were found with each imaging appearance We had 850 ATA category 4 lesions which have a 10-20% risk of malignancy. These can be described as solid hypoechoic nodules. 7% were found to be malignant We had 101 ATA category 5 lesions which have a greater than 70-90% risk of malignancy. These can have microcalcifications. They be hypoechoic with irregular margins or hypoechoic and be taller than wide. 31% of the hypoechoic nodules with calcifications were malignant where as 19% were found to be malignant if the nodule was hypoechoic with irregular margins.

CONCLUSION

2015 ATA guidelines; Overestimate the risk for malignancy , ephasize papillary over non-papillary cancers and may contribute to the ongoing over-diagnosis of thyroid nodules Improved risk stratification will help identify patients who will benefit from active surveillance rather than immediate fine-needle aspira

CLINICAL RELEVANCE/APPLICATION

The rapid increase of thyroid cancer is related to over-diagnosis ,87% are well differentiated (papillary) sub-clinical small cancers < 2 cm, majority progress slowly or not at all In 2015, the American Thyroid Association (ATA) presented guidelines for the management of this increasingly common clinical problem with an indolent prognosis

SSQ20-03 Propensity Score-Matched Comparison of Oncologic and Functional Mid-Term Outcomes Following Robotic Partial Nephrectomy and Percutaneous Radiofrequency Ablation for T1a Renal Cell Carcinoma

Thursday, Nov. 30 10:50AM - 11:00AM Room: N227B

Participants
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PURPOSE

To compare oncologic and functional mid-term outcomes following RPN and RFA using propensity score-matching.

METHOD AND MATERIALS

This retrospective HIPPA-compliant study was approved by institutional review board. Between December 2008 and April 2016, 287 and 80 patients underwent RPN or RFA for T1a RCC, respectively. Each treatment was performed by a single urologist or radiologist. Sixty-three patients from each treatment group were propensity score-matched for age, sex, American Society of Anesthesiologists score, tumor size, tumor laterality, tumor histology, R.E.N.A.L. nephrometry score, and preoperative estimated glomerular filtration rate (eGFR). RCC in RPN and RFA groups was histologically confirmed via surgery and biopsy, respectively. Posttreatment follow-up periods for RPN and RFA ranged from 1-90 months (median, 24.6 months) and 1-65 months (21 months), respectively. Tumor location, percentage of eGFR preservation, local recurrence rate, and 2-year recurrence-free survival rate were compared between groups.

RESULTS

Exophytic and endophytic RCC occurred in 73.0% (46/63) and 27.0% (17/63) of the RPN group, and in 52.4% (33/63) and 47.6% (30/63) of the RFA group, respectively (p=0.017). There was 91.7% preservation of eGFR in the RPN group and 86.8% in the RFA group (p=0.088). Local recurrence rates in the RPN and RFA groups were 0% (0/63) and 4.8% (3/63), respectively (p=0.244). However, two-year recurrence-free survival rate was 100% in the RPN group and 95.2% in the RFA group (p=0.029).

CONCLUSION

RPN may provide a higher recurrence-free survival rate than RFA. However, RFA can be a treatment option for an endophytic RCC that is difficult to treat with RPN.

CLINICAL RELEVANCE/APPLICATION

Increased likelihood of recurrent tumor should be informed to patients when RFA instead of RPN is chosen for treating T1a RCC.

SSQ20-04 Irreversible Electroporation in the Proximity of Surgical Clips is Safe

Thursday, Nov. 30 11:00AM - 11:10AM Room: N227B

Participants
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PURPOSE

Irreversible electroporation (IRE) is a minimal-invasive treatment option for hepatic malignancies close to vessels or bile ducts, due to its non-thermal ablation effect. Materials with good electric conductivity within the ablation zone could generate unwanted heating effects due to the induced electric current. Our aim was to evaluate the heating effects during IRE and the possible influences of surgical clips within the ablation zone.

METHOD AND MATERIALS

19 IRE procedures were performed in ex-vivo bovine liver tissue using the NanoKnife device (Angiodynamics) with 2 applicators. In each experiment three consecutive treatment cycles (each 90 pulses; pulse length 90 µs, 3000 Volt/cm) were performed immediately after each other. The electrode distance was fixed at 1.7 cm. At the midpoint between the electrodes, 4 points of interest (POI) for temperature measurements were established on a line perpendicular to the line connecting the electrodes (interelectrode line): 6 and 12 mm on both sides of the interelectrode line. On one side, a titanium surgical clip was placed at the 6 mm-POI. Temperature was measured every second at all 4 points during the electric pulse application. The mean temperature curve for all 19 ablations was calculated for each POI. After the IRE, the liver was dissected to evaluate possible tissue alterations.

RESULTS

IRE could be successfully performed in all 19 liver specimens. In the experiments an amperage of 15-20 A was reached. The titanium clip had no significant influence on the ablation temperature. The mean temperature increases at the 2 inner POI were 11.7 ± 4.5 °C (SD) and 10.3 ± 5.7 °C (SD), with a maximum of up to 20.4 °C. The mean temperatures at 6 mm to the interelectrode line were significantly higher compared to the temperatures on the same sides at 12 mm at all times during ablation with a maximum difference of 7.6 °C at the end of the energy deposition. ($p<0,00002$). Macroscopic evaluation of treatment zones showed no signs of heat-induced tissue alterations.

CONCLUSION

Titanium surgical clips have no influence on the ablation temperature during IRE. However, during pulse application a significant temperature increase was measured.

CLINICAL RELEVANCE/APPLICATION

IRE is a safe treatment option, even near surgical resection sites containing surgical clips. Substantial heating effects can occur in the center of IRE ablations, challenging the theory of a non-thermal ablation modality.

SSQ20-05 Heat Stress and Thermal Ablation Induced Expression of Nerve Growth Factor Inducible (VGF) in Hepatocytes and HCC Cells: Pre-Clinical and Clinical Studies

Thursday, Nov. 30 11:10AM - 11:20AM Room: N227B

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

Prior studies have shown that 1) sublethal heat stress of hepatocytes and HCC cells stimulates accelerated proliferation of HCC cells *in vitro* and 2) that thermal ablation of liver induces accelerated HCC tumor growth *in vivo*. The aim of the present study was to identify candidate growth factors induced by heat stress and thermal ablation *in vitro* and *in vivo* and in HCC patients undergoing thermal ablation.

METHOD AND MATERIALS

Hepatocyte and HCC cells underwent sublethal heat stress and were assessed for growth factor expression using expression microarray, qRT-PCR, western immunoblotting and ELISA. In an IACUC approved study, laser thermal ablation or sham ablation was performed in normal rat liver following HCC cell implantation. Rat liver and serum were harvested at 0-7 days post-ablation and analyzed for VGF expression using western-immunoblotting, immunohistochemistry and ELISA. Following IRB approval and informed consent, serum was collected from 16 patients undergoing thermal ablation for HCC at baseline, 3-6 hours and 18-24 hours post-ablation and analyzed for VGF using ELISA.

RESULTS

Sublethal heat stress induced a time-dependent significant increase in VGF mRNA (3-15 fold; $p<0.05$) and protein expression in both hepatocytes and HCC cells. Additionally there was a significant 3-fold increase in VGF concentration in the supernatant 48-72 hours following sublethal heat stress of HCC cells ($p <0.05$). Thermal ablation induced increased protein expression of VGF at the liver ablation margin 1-3 days post ablation and in HCC tumor 7 days post-ablation. There was no significant increase in serum VGF concentration following liver thermal ablation in rats or HCC thermal ablation in patients ($p>0.05$).

CONCLUSION

Sublethal heat stress and thermal ablation induce increased VGF expression in hepatocyte and HCC cells *in vitro* and in liver and HCC tumor *in vivo* but not in serum, thereby suggesting that heat stress induced VGF expression may be localized within the liver near the ablation zone. VGF warrants further investigation as a novel candidate growth factor mediating thermal ablation induced

accelerated intrahepatic HCC tumor growth.

CLINICAL RELEVANCE/APPLICATION

Nerve growth factor inducible (VGF) is induced by thermal ablation in the liver and may represent a novel growth mechanism mediating thermal ablation induced accelerated HCC tumor growth.

SSQ20-06 Irreversible Electroporation (IRE) for the Treatment of Recurrent Prostate Cancer (PCa) after Prostatectomy, Radiation Therapy and HiFU

Thursday, Nov. 30 11:20AM - 11:30AM Room: N227B

Participants
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Ross E. Schwartzberg, MD, San Diego, CA (*Presenter*) Nothing to Disclose

PURPOSE

Over the last 7 years we have successfully treated over 500 patients with primary prostate cancer with Irreversible Electroporation (IRE). Here we present our experience with IRE for the treatment of recurrent prostate cancer in 36 men with a minimum follow-up of 1 year. We discuss indication, technique, efficacy, toxicity, limitations and potential pit falls.

METHOD AND MATERIALS

36 men with recurrent prostate cancer (PCa) were treated with IRE. Initial treatments consisted of: radical prostatectomy (RPE; N=9), external beam radiation (RT; N= 14), RPE and RT (N=4), high energy focal ultrasound (HiFU; N=7) and brachytherapy (N=2). Initial PCa stages were T1 (N=4), T2 (N=12), T3 (N=8), T4 (N=6) and NA (N=6), respectively. Mean follow-up time after IRE was 25.7 months (min. 13, max. 72 months). Follow-up was performed in with PSA and multi-parametric (mp)MRI in all and PSMA-PET/CT and re-biopsy in selected cases. Erectile function and urinary continence were assessed by IIEF5 and ICIQ questionnaires; all other adverse events were recorded and classified by CTCAE criteria.

RESULTS

In all cases mpMRI (DCE-sequences) showed complete ablation. Grade 0 to 1 adverse events were observed in 29 cases. Grade 2 (moderate) adverse events were observed 4 cases (urinary tract infections). A Grade 3 (severe) adverse events was observed in 3 cases (urinary retention). No Grade 4 or 5 events were noted. There was no statistically significant change in the recorded ICIQ (urinary continence) nor IIEF5 scores before and 6 months after IRE.

CONCLUSION

IRE is a suitable technique for the treatment of recurrent PCa after RPE, RT, brachytherapy and HiFU. It can be employed with lower toxicity than other second line treatments such as salvage RPE and/or RT. This could establish IRE as a 'problem solver' technology for recurrent PCa.

CLINICAL RELEVANCE/APPLICATION

Irreversible Electroporation (IRE) is a suitable treatment for recurrent PCa. Its low toxicity affords local tumor control without damage of crucial anatomical structures, particularly after RT.

SSQ20-07 Contrast-enhanced Ultrasound as an Assessment Method During Microwave Ablation for Benign Thyroid Nodules: A Prospective Study

Thursday, Nov. 30 11:30AM - 11:40AM Room: N227B

Participants
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PURPOSE

The major goal of ultrasound - guided microwave ablation (MWA) procedure is to reduce the volume and eliminate the activity of benign thyroid nodules. The purpose of our present study is to observe the value of contrast-enhanced ultrasound (CEUS) during both pre- and post-treatment evaluation of MWA for benign thyroid nodules.

METHOD AND MATERIALS

Between June 2016 and February 2017, 86 patients with a total of 86 benign thyroid nodules who were admitted to our hospital for WMA treatment were included. A microwave system including a microwave generator, a flexible low-loss coaxial cable and an internally cooled shaft antenna was used. The generator is designed with a frequency of 2450 MHZ and a maximum output power of 100W. The MWA antenna is 16-gauge (10cm in total length, 1.6mm in diameter, 3 mm in length of the active tip). The ablation procedures were monitored by real-time ultrasound. Before MWA, dynamic CEUS examinations were performed to make pre-treatment assessment, including blood perfusion of nodules and their relationship with surrounding large vessels. One day and six month after ablation, the post-treatment CEUS were conducted to evaluate whether the original nodule was completely ablated.

RESULTS

During pre-ablation CEUS evaluation, peripheral hyperenhanced rings were detected during arterial phase of all nodules, with mean thickness 1.4 ± 0.6 mm. Fifteen nodules were located very close to superior or inferior thyroid artery. MWA were conducted successfully in all 86 thyroid nodules. Post-ablation CEUS showed that 82 (95.3%) nodules with complete ablation had no enhancement. The peripheral hyperenhanced ring disappeared in all nodules. The volume reduction of 91 ± 7.3 % was achieved with benign thyroid nodules after six months by ultrasound guided MWA. No major complications occurred.

CONCLUSION

Microwave ablation with real time ultrasound guidance is an effective and safe method in treatment of benign thyroid nodules. CEUS is a sensitive and effective method to make both pre-treatment evaluation and post-treatment efficacy of MWA.

CLINICAL RELEVANCE/APPLICATION

With application of CEUS both pre-and post-treatment of WMA, we can guarantee the effective and safety of treatment.

SSQ20-08 Percutaneous Cryoablation of Lymph Node Metastases

Thursday, Nov. 30 11:40AM - 11:50AM Room: N227B

Participants
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PURPOSE

To assess the safety and efficacy of percutaneous computed tomography (CT)-guided cryoablation for local control of lymph node metastases in patients with oligometastatic malignancy.

METHOD AND MATERIALS

In this single-institution study, a retrospective search of the institutional cryoablation database identified 39 unique patients (mean age 64 ± 14 years; 33 men, 6 women) treated with 45 cryoablation procedures targeting a total of 48 lymph nodes between October 2006 and March 2017. Patient demographics, disease characteristics, and procedural details were recorded. Primary endpoints were technical success and complications. The secondary endpoint was time to local progression. Technical success was defined as complete coverage of the target node by the ablation zone. Complications were graded according to the Society of Interventional Radiology consensus guidelines. Time to progression was calculated using the Kaplan-Meier method.

RESULTS

Technical success was achieved in 100% of cases. Targeted nodes measured 1.8 ± 1.6 cm (mean short axis diameter). Adjunctive maneuvers performed to protect adjacent structures included hydrodissection (n=28) and preprocedural ureteral stenting (n=2). There were no major complications. One patient developed a subcutaneous hematoma following ablation of an axillary lymph node and required thrombin injection to control bleeding. Another patient developed a tiny apical pneumothorax following ablation of a supradiaphragmatic node, prompting temporary chest tube placement and overnight observation. Mean imaging follow-up duration was 17.3 months. Local recurrence occurred in 9/48 cases (19%) with a mean time to progression of 18.8 ± 3.1 months.

CONCLUSION

Percutaneous cryoablation is a safe and effective therapy for achieving local control of lymph node metastases in the setting of oligometastatic malignancy. Further investigation is warranted to determine long-term efficacy.

CLINICAL RELEVANCE/APPLICATION

Percutaneous image-guided cryoablation is safe and effective for treatment of limited nodal metastases and may be a useful adjunct to other oncologic therapies for achieving local control of oligometastatic disease.

SSQ20-09 Tumor Response Assessment in Unresectable Hepatocellular Carcinoma (HCC) Patients: Functional MRI as a Substitute for Traditional Anatomic Sized Based Tumor Response Assessment

Thursday, Nov. 30 11:50AM - 12:00PM Room: N227B

Participants
Mounes Aliyari Ghasabeh, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
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PURPOSE

The aim of this study was to evaluate superiority of functional MRI biomarkers to traditional sized based criteria in assessing tumor response in unresectable HCC patients who had trans- arterial chemoembolization (TACE).

METHOD AND MATERIALS

One hundred and seventy HCC patients with unresectable lesions were enrolled in this retrospective HIPAA- compliant study. Informed consent was waived. All patients had baseline MRI, 3-4 weeks and 6 months' follow-up MRI after TACE therapy. Change in functional MRI biomarkers (Apparent diffusion coefficient (ADC), artriovenous enhancement (ENH) and tumor volume) were measured on 3-4 weeks MRI using a semiautomatic volumetric software package (Onco Treat, 3.1.1, Siemens). Anatomic response variables including Response Evaluation Criteria in Solid Tumors (RECIST), modified RECIST (mRECIST), and European Association for the Study of the Liver (EASL) were measured on 6 months' follow-up MRI. Patients were stratified into responder and non-responder groups based on median survival (20 months). Change in functional variables (ADC, ENH, tumor volume) at 1 month and change in anatomic variables (RECIST, mRECIST, EASL) at 6 months were measured for each group. Hazard ratio (HR) was calculated for all variables with Cox proportional hazards model.

RESULTS

Mean volumetric change in ADC, ENH, tumor volume, RECIST, mRECIST and EASLE were summarized in Table 1. ADC and ENH change were significantly different between responder and non- responder group ($p= 0.0007$ and 0.001; respectively) whereas tumor volume, RECIST, mRECIST and EASLE were not ($p= 0.6$, 0.23, 0.34, 0.4; respectively). Patients with greater than 15% increase in ADC demonstrated better overall survival (OS) compared with those with <15% increase in ADC; hazard ratio for predicting increased OS was 0.59 (95% CI: 0.3- 0.8; $p= 0.01$) (Fig 1-A, B). Also, patients with greater than 23% decrease in ENH demonstrated better OS than those who did not; HR: 0.60 (95% CI: 0.4-0.5; $p= 0.01$) (Fig 1-C, D).

CONCLUSION

ADC and ENH changes precede and are superior to anatomic criteria is assessing treatment response to TACE.

CLINICAL RELEVANCE/APPLICATION

Functional MRI biomarkers provide early and more accurate prediction of tumor response in HCC patients undergoing TACE. These metrics can potentially be used in future clinical trials.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ihab R. Kamel, MD, PhD - 2015 Honored Educator

SST01

Breast Imaging (Multimodality Diagnostic)

Friday, Dec. 1 10:30AM - 12:00PM Room: E450B

BR MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Mary S. Newell, MD, Atlanta, GA (*Moderator*) Stockholder, Kimberly-Clark Corporation ; Stockholder, E. I. du Pont de Nemours & Company ; Stockholder, Bristol-Myers Squibb Company; Stockholder, Merck & Co, Inc; Stockholder, Johnson & Johnson ; Stockholder, Eli Lilly and Company
Sarah M. Friedewald, MD, Chicago, IL (*Moderator*) Consultant, Hologic, Inc; Research Grant, Hologic, Inc;

Sub-Events

SST01-01 Specialized Second Opinion Interpretations of Breast Imaging: Impact on Additional Workup and Management

Friday, Dec. 1 10:30AM - 10:40AM Room: E450B

Participants
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PURPOSE

Patients with breast imaging often seek second opinion review at tertiary care centers. The goal of our study is to evaluate the impact of these second opinions on patient management.

METHOD AND MATERIALS

A retrospective chart review was conducted on 504 consecutive patients with second opinion radiology interpretations performed by six sub-specialized breast radiologists at a cancer center from January 1st through September 1st of 2014. Outside imaging reports were compared to second opinion reports to categorize interpretation discrepancies. Interpretations were considered discrepant in cases with a clinically relevant BI-RADS category change or identification of previously undiagnosed additional extent of disease greater than 5 cm. The frequencies of discrepant BI-RADS categorizations, clinically significant alterations in surgical management, and incremental cancer detection were measured. Statistical analyses were performed with Fisher's exact test with a p-value <0.05 considered significant.

RESULTS

Presenting diagnoses at second opinion interpretation included invasive malignancy (356), Ductal Carcinoma in Situ (78), high risk lesions (16), suspicious findings (21), probably benign findings (4), BI-RADS 0 (1), and negative or benign findings (28). Second opinions resulted in interpretation discrepancies in 287 patients (57%) and percutaneous image-guided biopsies in 94 (19%). Additional sites of cancer were detected in 48 (10%), including 13 ipsilateral and 8 contralateral breast malignancies, and 27 axillary metastases. Another 5 biopsies yielded high-risk pathology. Second opinion interpretations altered surgical management in 58 (12%) due to the detection of additional cancer, a high risk lesion at biopsy, additional extent of disease, or stage 4 disease. Factors associated with increased discrepancy frequency included diagnosis of invasive or in situ cancer at presentation (p=0.003), dense breasts (p=0.005), and the absence of prior studies available for comparison (p=0.007).

CONCLUSION

Though additional imaging and resources are required, pre-operative second opinion radiology review by subspecialized radiologists increases cancer detection and results in clinically relevant changes in patient management.

CLINICAL RELEVANCE/APPLICATION

Second opinion interpretation of breast imaging by subspecialized breast radiologists resulted in additional cancer detection in 10% and altered surgical management in 12% of patients.

SST01-02 Radiomics Signature on 3T DCE-MRI for Estrogen Receptor-Positive Invasive Breast Cancers: Preliminary Results in Predicting Oncotype DX Test Recurrence Score

Friday, Dec. 1 10:40AM - 10:50AM Room: E450B

Participants
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PURPOSE

To evaluate the ability of quantitative computer extracted imaging features on 3T dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) to distinguish estrogen receptor (ER)-positive invasive breast cancers between the low and non-low Oncotype DX risk categories.

METHOD AND MATERIALS

Between May 2011 to March 2016, we retrospectively enrolled 67 ER-positive invasive breast cancer patients who performed preoperative 3T breast DCE-MRI and Oncotype DX assay. We divided the patients into low (Oncotype DX recurrence score [RS] <18) and non-low risk (RS >= 18) groups. Extracted radiomics features included morphological, histogram-based, and higher-order texture features. The least absolute shrinkage and selection operator (LASSO) method was used for feature selection, and radiomics signature (Rad-score) was calculated via a linear combination of selected radiomics features. Logistic regression analysis was performed to investigate the association between Oncotype DX risk groups and clinicopathologic, MR imaging, and Rad-score. Receiver operating characteristic analysis and the area under the receiver operating characteristic curve (Az) were used to assess classification performance.

RESULTS

The Rad-score was constructed for each tumor by extracting thirteen of 158 radiomics features (8.2 %). Multivariate regression analysis showed that there was a significant difference in the Rad-score between the low and non-low Oncotype DX risk groups (P = 0.001). The Rad-score was able to differentiate between low and non-low risk Oncotype DX groups with an Az of 0.822 . The significant pathologic factors in univariate analysis achieved an Az of 0.574. Addition of Rad-score to the significant pathologic factors in univariate analysis showed an Az of 0.889.

CONCLUSION

The Rad-score that incorporates the radiomics features of DCE-MRI was highly associated with the low and non-low Oncotype DX risk classifications in patients with ER-positive invasive breast cancers.

CLINICAL RELEVANCE/APPLICATION

The Rad-score could allow for non-invasively predicting which ER-positive patients might have little to no benefit from adjuvant chemotherapy.

SST01-03 Volume-Based Metabolic Parameter of Tumor on Preoperative 18F-FDG PET/CT May Predict Axillary Lymph Node Metastasis

Friday, Dec. 1 10:50AM - 11:00AM Room: E450B

Participants
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PURPOSE

The purpose of our study was to evaluate the association between metabolic parameters on FDG PET/CT and axillary lymph node metastasis (ALNM) in patients with invasive breast cancer.

METHOD AND MATERIALS

From January 2012 to December 2012, we analyzed 173 patients with invasive ductal carcinoma (IDC) who underwent both initial breast MRI and 18F-FDG PET/CT examinations. All metabolic parameters were measured from the tumor volume segmented by a gradient-based method. Once the primary target lesion was segmented, maximum standardized uptake value (SUVmax), mean standardized uptake value (SUVmean), metabolic tumor volume (MTV) and total lesion glycolysis (TLG) were calculated automatically by the MIMvista software.

RESULTS

Mean age of 173 patients was 49 years old. Of 173 patients, 45 (26%) showed axillary lymph node metastasis. On univariate analysis, larger tumor size (> 2.2 cm; p=0.002), presence of lymphovascular invasion (p < 0.001), higher SUVmax (> 2.82; p=0.038), higher SUVmean (> 1.2; p=0.027), higher MTV (> 2.38; p < 0.001) and higher TLG (> 3.98; p = 0.007) were associated with a higher probability of axillary lymph node metastasis. On multivariate analysis, presence of lymphovascular invasion (adjusted odds ratio [OR], 11.053; 95% CI, 4.403-27.751; p < 0.001) and higher MTV (> 2.38) (adjusted OR, 2.696; 95% CI, 1.079-6.739; p=0.034) maintained independent significance in predicting ALNM. In subgroup analysis of T2/T3 breast cancer, lymphovascular invasion (adjusted OR, 20.976; 95% CI, 5.431-81.010; p < 0.001) and higher MTV (> 2.38) (adjusted OR, 4.906; 95% CI, 1.616-14.896; p=0.005) were independent predictors of ALNM. However in T1 breast cancer, lymphovascular invasion (adjusted OR, 16.096; 95% CI, 2.517-102.939; p=0.003) and larger SUV mean (> 1.2) (adjusted OR, 13.275; 95% CI, 1.233-142.908; p=0.033) were independent predictors while MTV was not.

CONCLUSION

MTV may be associated with ALNM in patients with invasive breast cancer, particularly T2 and T3 stages. In T1 breast cancer, SUVmean was associated with ALNM.

CLINICAL RELEVANCE/APPLICATION

Metabolic tumor volume in 18F-FDG PET/CT may be associated with axillary lymph node metastasis in patients with invasive breast cancer, particularly T2 and T3 stages.

SST01-04 Visibility of Mammographically Occult Breast Cancer on Diffusion-Weighted MRI versus Ultrasound

Friday, Dec. 1 11:00AM - 11:10AM Room: E450B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

There is widespread interest in identifying an effective and affordable breast cancer screening exam that can supplement mammography. While dynamic contrast-enhanced (DCE)-MRI is highly sensitive and currently recommended for high-risk women, cost and gadolinium-related safety concerns limit its wider use. Screening ultrasound (US) can identify some mammographically-occult malignancies but is time consuming and associated with low specificity. Diffusion-weighted MRI (DWI) is emerging as a promising non-contrast technique for breast cancer detection. We sought to investigate the visibility of mammographically-occult cancers on DWI versus US.

METHOD AND MATERIALS

This IRB-approved study retrospectively evaluated patients with 3T DCE-MRI detected mammographically-occult cancers who underwent pre-biopsy targeted US (12/2010 to 12/2013). DWI was performed during clinical breast MRI exams (b= 0, 100, and 800 s/mm2). Lesion visibility on DWI was scored visually (1=isointense to 5=focal hyperintensity) by three independent readers (not blinded to DCE). DWI visibility was defined as a mean score of >=2.5. US visibility was determined from imaging reports. Clinical factors (age, breast density, lesion size, morphology, and histology) were collected, and DWI and US lesion visibility were compared across and within subgroups using McNemar's Test.

RESULTS

During the study period, 60 mammographically-occult cancers (53 invasive; 7 DCIS) were imaged by both DWI and US in 53 women (median age 53 years, range 23-75 years). Cancers ranged in size from 4 to 102mm (median, 12mm) and included 39 masses, 20 non-masses, and 1 focus. More cancers were visible on DWI (47/60, 78%) than on US (38/60, 63%; p=0.049), with 32 (53%) visible on both modalities and 7 (12%) not visible on either. Subanalyses suggested better visualization by DWI versus US in particular for larger cancers (>=1cm; p=0.011), which had a higher proportion of non-masses than smaller cancers (51% vs. 8%), and for cancers in younger women (<50years; p=0.06, trend).

CONCLUSION

Mammographically-occult breast cancers may be more visible on DWI than ultrasound. DWI continues to show promise as a cost-effective supplemental screening tool, and warrants further investigation.

CLINICAL RELEVANCE/APPLICATION

Diffusion-weighted MRI may be more sensitive than ultrasound for detecting mammographically occult cancer, and may provide a safe, fast, and affordable supplemental tool for screening women.

SST01-05 Outcomes in Patients with a Focal Area of Clinical Concern Assessed as Probably Benign on Diagnostic Imaging

Friday, Dec. 1 11:10AM - 11:20AM Room: E450B

Participants
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PURPOSE

The American College of Radiology (ACR) Appropriateness Criteria support either short-term follow-up or biopsy for women presenting with a palpable solid breast mass demonstrating probably benign (BIRADS category 3) features on imaging. To support

decision-making in this clinical scenario, we measured outcomes of BIRADS 3 cases in a large population of women presenting with a focal area of clinical concern.

METHOD AND MATERIALS

Following IRB approval, review of the electronic medical records identified 15,548 cases of diagnostic mammography with ultrasound that evaluated a focal area of clinical concern from 3/2006 to 3/2014. Each breast with one or more focal areas of clinical concern was designated as a case. Outcomes were determined by imaging, biopsy or any pathology in our hospital tumor registry at 24-month follow-up. Performance measures were defined according to the ACR BIRADS atlas, 5th edition.

RESULTS

Of the 15,548 cases, 965 (6.2%) were assessed as BIRADS 3 in 861 women (average age 47.7, range 24-89). During the 24-month follow-up, only one cancer, an invasive ductal carcinoma, was diagnosed with a cancer yield of 0.1% (1/965). In addition to the one biopsy-proven malignancy, another 29 cases underwent biopsy/tissue sampling for a positive predictive value (PPV3) of 3.3% (1/30) within the follow-up period.

CONCLUSION

The risk of subsequent breast malignancy diagnosis in patients presenting with focal areas of clinical concern assessed as BIRADS 3 is extremely low (0.1%). These findings strongly support the current ACR guidelines suggesting surveillance as a safe alternative to biopsy in these patients. Given the high likelihood of benignity and the low PPV3 (3.3%), additional research may facilitate reclassification of a subgroup of probably benign lesions as benign by imaging (BIRADS 2) with recommendation for clinical follow-up.

CLINICAL RELEVANCE/APPLICATION

Follow-up of symptomatic probably benign lesions has a low rate of malignancy, supporting the ACR guidelines with opportunity to improve stratification of benign vs. probably benign palpable masses.

SST01-06 Deep Learning through Convolution Neural Networks Using a Breast MRI Tumor Dataset Can Predict Oncotype Dx Recurrence Score

Friday, Dec. 1 11:20AM - 11:30AM Room: E450B

Participants
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PURPOSE

We hypothesize that CNNs can be used to predict Oncotype Dx Recurrence Score (RS), which is a validated, gene-expression-based, aggressiveness assay using a breast MRI tumor dataset.

METHOD AND MATERIALS

An IRB approved retrospective review of our database from 1/2010 to 6/2016 identified 134 patients with ER+/HER2- invasive ductal carcinoma who underwent both breast MRI and Oncotype Dx RS evaluation. Patients were classified to 3 groups: Low risk (group 1, RS < 18), intermediate risk (group 2, RS of 18- 30) and high risk (group 3, RS > 30). For deep learning, 134 cases were separated into 80% (107/134) training set and 20% (27/134) test set. For each breast MRI, tumor was identified on first T1 post contrast dynamic images and underwent 3D segmentation using an open source software platform 3D Slicer. Then, 32x32 patch was extracted from the center slice of the segmented tumor data. A CNN was designed for Oncotype DX class prediction based on each of these cropped images. In brief, CNN consisted of 4 convolution layers, max-pooling layers and dropout of 0.25 after each convolution layer. Two models were created, one for three class Oncotype Dx prediction (group 1, group 2 or group 3) and a second for two class prediction (group 1 vs. group 2 and group 3). Code was implemented in open source software Keras with TensorFlow on a Linux workstation with NVIDIA GTX 1070 Pascal GPU.

RESULTS

Three class Oncotype Dx prediction model was evaluated in 3 groups consisting of 77, 40 and 17 patients in groups 1, 2 and 3. The CNN achieved an overall accuracy of 80% in three class prediction. Two class Oncotype Dx prediction model was evaluated in 2 groups consisting of 77 and 57 patients (group 1 vs. groups 2 and 3). The CNN achieved an overall accuracy of 92% in two class prediction.

CONCLUSION

Current deep CNN architectures can be trained with relatively small MRI data set to achieve useful performance at predicting Oncotype DX RS. Research is underway with a larger dataset to improve our prediction model.

CLINICAL RELEVANCE/APPLICATION

Deep learning through convolution neural networks (CNNs) have demonstrated strong performance in various image classification tasks in recent years and may be used to predict patients' likelihood of breast cancer recurrence.

SST01-07 Classifying Breast Lesions with Initial Enhancement Kinetics from High Temporal-Resolution DCE-MRI

Friday, Dec. 1 11:30AM - 11:40AM Room: E450B

Participants
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PURPOSE

To identify parameters descriptive of initial lesion enhancement on high-temporal resolution breast DCE-MRI that may aid in ruling out malignancies

METHOD AND MATERIALS

46 patients with dense breasts and BIRADS 4 or 5 on screening mammograms were enrolled. Participants received an MRI prior to biopsy, including high temporal resolution DCE-MRI ('ultrafast') during the first minute after contrast administration, followed by a standard high-spatial resolution acquisition. Patients were scanned on 1.5T and 3T scanners with temporal resolutions from 3.5 to 10 seconds. Relative signal enhancement was calculated on a voxel-by-voxel basis. Signal enhancement was fit to an empirical model with 3 parameters: upper limit of enhancement, uptake rate, and time of initial enhancement (TIE). Initial slope and initial area under the curve (iAUC) were calculated from the fit parameters. The time of initial arterial enhancement was measured in the internal mammary arteries and lesion enhancement times were calculated relative to this time

RESULTS

65 lesions were included in this analysis (27 benign, 38 malignant). Two cases showed no abnormal enhancement (on ultrafast or standard DCE); both biopsy results were benign. Benign and malignant lesions had average TIEs of 9.5 ± 12.8s and 5.7 ± 3.3s, respectively. the difference was not significant but 10 benign lesions (37%) had higher TIEs than the maximum TIE for all malignant lesions (12.1s). Initial slope and iAUC were significantly different ($p<0.005$) between benign and malignant lesions, with average malignant-to-benign ratios of 1.96±0.06 and 1.49±0.04. The negative predictive value of iAUC was 93%

CONCLUSION

These preliminary results suggest that IAUC, initial slope, and TIE from ultrafast DCE-MRI have strong negative predictive value, and may be used to rule out cancer and reduce unnecessary biopsies. This type of analysis requires only 1 minute of high-temporal resolution imaging. Ultrafast imaging allows reliable measurements of initial kinetics that are less sensitive to global variables (e.g., cardiac output) and descriptive of lesion physiology

CLINICAL RELEVANCE/APPLICATION

High-temporal resolution DCE allows accurate measurements of very early enhancement kinetics, when differences between benign and malignant lesions may be largest, and may provide strong negative predictive power

SST01-08 A Reader Study of MARIA Radiowave Breast Imaging Compared with X-Ray Mammography for the Symptomatic Breast

Friday, Dec. 1 11:40AM - 11:50AM Room: E450B

Participants
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PURPOSE

MARIA is a new, non-ionising, non-compressing radiowave breast imaging modality with good dense breast performance which has early potential as an adjunct to x-ray mammography (MMG). This study presents a sensitivity comparison of MARIA and MMG using offline reads of the respective images.

METHOD AND MATERIALS

Females attending a symptomatic breast clinic at one of 3 UK symptomatic clinics (Southmead - Bristol, Thirlestaine - Cheltenham, Great Western - Swindon), were identified by clinicians as having a palpable lump. Following informed consent, eligible patients meeting inclusion criteria were scanned in the prone position with MARIA, a non-ionising, multi-static radar system (Yorkshire & The Humber and South Yorkshire REC 15/YH/0084) ClinicalTrials.gov NCT02493595. Patients had ultrasound scan (US) and/or mammography (MMG). Cytology/ histology was conducted as necessary as part of normal clinical procedure and final diagnosis was determined. Both MARIA and MMG were read offline by independent readers who had no knowledge of the clinical outcome. Features identified in either modality were subsequently compared to the diagnosis on discharge (including histology/ cytology where available) to determine a sensitivity score.

RESULTS

145 single breast studies were analysed. MMG sensitivity, defined as successful detection of the symptomatic index lesion, was 79% (42/52) in lucent (BI-RAD a,b) while MARIA sensitivity in lucent was 71% (37/42). For dense breasts (BI-RAD c, d), sensitivity for MMG was 54% (50/92) while for MARIA it was 77% (71/92).

CONCLUSION

Initial results suggest that the MARIA system offers the provision of a safer (non-ionising), more comfortable (no breast

Initial results suggest that the MARIA system offers the provision of a safer (non-ionising), more comfortable (no breast compression) and inexpensive breast screening alternative compared to other modalities, which has been shown to be effective at detecting cancers in younger, pre-menopausal women with dense breasts. MARIA may also overcome some of the challenges posed by trying to optimise the balance between benefit and harm of MMG screening in women of younger age.

CLINICAL RELEVANCE/APPLICATION

The sensitivity of MMG is low for women with dense breasts (DB). MARIA shows great promise as a whole-breast adjunct offering a benign, more comfortable, sensitive diagnostic for women with DB.

SST01-09 Quantitative Assessment of Breast DCE-MRI BPE and Mammographic Breast Density Changes over Time

Friday, Dec. 1 11:50AM - 12:00PM Room: E450B

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PURPOSE

Breast DCE-MRI background parenchymal enhancement (BPE) has been reported associated with breast cancer risk, potentially independent of the established mammographic breast density (MBD). We investigated quantitative characteristics and temporal changing patterns of BPE and MBD on a large (1792) set of MRI scans and mammogram examinations acquired from breast cancer-free women.

METHOD AND MATERIALS

We retrospectively identified 886 longitudinal breast DCE-MRI scans (2006-2015) and 886 mammogram examinations acquired in the same year with the MRI from 266 high-risk screening women (each with 2-9 sequential scans). For the 886 MRIs, the average age-at-scan was 50.4±9.3 YO, average between-scan time was 419±165 days, and 552 (62%) were post-menopausal with the rest pre-menopausal. All 266 women remain breast cancer-free at the time of this study. Fully automated computerized methods were applied to quantify BPE and area-based MBD (an average on CC and MLO view), both at unilateral and bilateral levels. BPE was computed from the first post-contrast sequence as the volumetric percentage of enhanced voxels over the fibroglandular tissue. Descriptive statistics, nonparametric regression, and linear mixed effects modeling were used to assess distributions and changing patterns of BPE and MPD over time.

RESULTS

Mean BPE was 22.2%±13.5 for all scans, and was 25.3%±14.8 for pre- and 20.4%±12.4 for post-menopausal scans (unpaired t-test $p<0.0001$). Likewise for MBD, mean was 29.7%±16.6 for all mammogram examinations, 31.9%±16.5 for pre- and 28.4%±16.7 for post-menopausal ($p=0.0027$). The Pearson's correlation coefficient between left and right BPE (or MBD) was 0.85 (or 0.90). Both BPE and MBD change over time in a roughly linear decreasing trend and both statistically significant ($p<0.05$) with respect to the evaluation of accumulated-years-since-first-scan, but the rate of change for MBD (0.7 percentage point/year, 95% CI 0.2-1.2) is somewhat less than for BPE (0.9 percentage point/year, 95% CI 0.5-1.3).

CONCLUSION

In longitudinal imaging scans of breast cancer-free women, both BPE and MBD are higher among pre- than post-menopausal women. They both decrease roughly linearly over time, but the trend of MBD is less pronounced than BPE.

CLINICAL RELEVANCE/APPLICATION

Quantitative assessment of temporal changing characteristics of BPE and MPD in cancer-free women can help determine their performance and mechanisms as independent breast cancer risk biomarkers.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
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SST02

Cardiac (General Topics, CT, SPECT, and PET)

Friday, Dec. 1 10:30AM - 12:00PM Room: E450A

CA CT NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

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Sub-Events

SST02-01 Automatic Segmentation and Volume Quantification of Fat Surrounding the Heart in Non-Contrast CT using Deep Learning

Friday, Dec. 1 10:30AM - 10:40AM Room: E450A

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PURPOSE

Increased volume of thoracic fat surrounding the heart (TFV) is predictive of major adverse cardiovascular events, however, its measurement has previously relied on time-consuming manual quantification which is prone to variability. We developed a fast and robust algorithm to automatically quantify TFV using deep learning methods.

METHOD AND MATERIALS

The Deep Learning method was divided into two parts: (i) a convolutional network used for heart segmentation for non-contrast CT axial slices and (ii) a second convolutional neural network used to identify superior and inferior heart limits. These two networks, implemented with the standard Caffe library on graphics display cards for fast training performance, were combined to provide a binary mask of the heart and thoracic fat. Standard fat range attenuation (-190 to -30 HU) was then applied and allowed for fat segmentation. Deep Learning was validated using 10-fold cross validation in 250 non-contrast coronary calcium scoring CT datasets, with expert fat and heart identification as the reference standard.

RESULTS

Median TFV was 130.354 cm3 (Inter-quartile range [IQR]: 89.121-198.183) and 130.936 cm3 (IQR: 87.244-193.696) for expert and automatic quantifications, respectively, with no significant difference ($p>0.99$). An excellent correlation was obtained between the two measures ($R=0.944$, $p<0.00001$), with a non-significant bias of -0.003 cm3 (95% confidence interval: -3.287 to 3.280) according to Bland-Altman analysis. The algorithm is now implemented in our homemade visualization software and allows for automatic TFV quantification of a new case within 20 seconds on a standard personal computer compared to approximately 10 minutes of expert measurement.

CONCLUSION

Using deep learning methods, we developed a fast, fully automated algorithm to segment the heart and quantify TFV from non-contrast CT data sets, with high correlation and agreement with expert measurement. This algorithm may allow for routine, efficient TFV quantification to aid cardiovascular risk assessment and improve the prediction of major adverse cardiovascular events.

CLINICAL RELEVANCE/APPLICATION

Deep Learning algorithm can perform fast and robust quantification of fat surrounding the heart in non-contrast CT data sets and allow for clinical routine quantification and prediction studies.

SST02-02 Use of 18-F FDG PET/CT for Diagnosis of Cardiac Device Infections

Friday, Dec. 1 10:40AM - 10:50AM Room: E450A

Participants
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PURPOSE

Cardiac device infections can be challenging to diagnose, there is growing evidence to support the role of 18-F fluorodeoxyglucose (FDG) PET/CT imaging as a complementary diagnostic tool in patients with suspected cardiac device infections. We hypothesize that nuclear imaging will be useful in excluding cardiac device infections, particulary in cases with a low or intermediate pre-test probability of infection.

METHOD AND MATERIALS

Patients with possible cardiac device infection who underwent 18-F FDG PET/CT as part of the evaluation for possible cardiac device infection at a tertiary institution from 2006-2016 were retrospectively reviewed to evaluate the utility of PET/CT as an adjunctive diagnostic tool. We collected clinical, microbiologic, echocardiographic, imaging and outcomes data for at least 90 days following imaging. PET/CT and echocardiograms were reviewed again for the purposes of the study by independent investigators.

RESULTS

Thirty patients with possible cardiac device infection who underwent 18-F FDG PET/CT were reviewed. The most common presenting symptoms were fever in 60% and generator pocket site skin changes or tenderness in 40%. Blood cultures were positive in 59%; the most common organisms identified were coagulase negative Staphylococcus (23%), *Staphylococcus aureus* (23%) and Enterococcus (23%). Average maximum standardized uptake values (SUVmax) were 4.81 for positive PET/CT and 1.38 for negative PET/CT scans. Positive PET/CT was correlated with presence of generator pocket signs (p=0.0027) and positive generator pocket cultures (p=0.0145). PET-CT results were not correlated with fever (p=0.06), leukocytosis (p=0.70), elevated ESR or CRP (p=0.10), positive blood cultures (p=0.26) or positive echocardiographic findings (p=0.39). Overall 18-FDG PET/CT demonstrated senstivity of 86.67% (95% confidence interval [CI] 59.54% to 98.34%) and specificity of 93.33% (95% CI 68.05% to 99.83%) for diagnosis of cardiac device infections.

CONCLUSION

18-F FDG PET/CT is a valuable adjunctive diagnostic tool with a high sensitivity of 86.67% and specificity of 93.33% for diagnosis of possible cardiac device infections.

CLINICAL RELEVANCE/APPLICATION

18-F FDG PET/CT is a useful adjunctive diagnostic tool in challenging cases of cardiac device infections.

SST02-03 Reliability and Homogeneity of the CT Attenuation at Different Contrast Medium Concentration on 16cm Wide-Detector Revolution CT: A Phantom Experiment Study

Friday, Dec. 1 10:50AM - 11:00AM Room: E450A

Participants
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PURPOSE

To evaluate CT attenuation homogeneity and reliability of 16cm wide-detector revolution CT at different contrast medium concentration with a phantom experiment study.

METHOD AND MATERIALS

A phantom (QSP-1, FUYO) with nine cylindrical tubes of 18-mm-diameter and16-cm-length placed into water tank was used. One was in central region filled with saline and other eight tubes were in periphery region filled with contrast medium concentration of 2.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0mg/mL. The phantom was scanned on revolution CT at 120 kVp using both axial 16cm protocol and helical 4cm protocol with 5mm thickness, respectively. Circular regions of interest of the same area were placed at the center of each tube to measure the CT attenuation value and the standard deviation. CT attenuation homogeneity of each tube was evaluated by variation range (VR: maximum attenuation-minimum attenuation) and degree of dispersion (DD:defined as percentage of variance range divided by mean attenuation), and coefficient of variation (CV: defined as percentage of standard deviation of CT attenuation divided by mean attenuation). Data were analyzed by using paired t test.

RESULTS

The variation range(VR) of CT attenuation ,degree of dispersion(DD) and coefficient of variation(CV)) of each tube filled with different density of iodine contrast medium was (5.65HU ,9.99%, 2.47%), (5.99HU,4.68%, 1.15%), (6.66HU,5.02%, 1.12%),

(12.46HU ,3.30%, 0.79%), (15.04HU,3.06%, 0.77%), (16.86HU, 2.86%, 0.81%), (20.07HU (2.87%, 0.77%) for axial 16-cm mode whereas those values for helical 4-cm mode were (7.17HU, 12.07%, 2.78%), (9.97HU ,7.75%, 2.21%), (13.78HU ,10.43%, 3.20%), (17.07HU ,4.56%, 1.16%), (8.88HU ,1.8%, 0.51%), (7.73 HU, 1.31%, 0.32%), (8.51HU ,1.21%, 0.31%). There were no significant differences between axial 16-cm mode and helical 4-cm mode in VR of CT attenuation, DD and CV (P = 0.642,0.343,0.332, respectively).

CONCLUSION

Axial 16-cm wide-detector scanning protocol on revolution CT at different density of iodine contrast medium can provide the same CT attenuation homogeneity and reliable CT value with helical 4-cm standard-detector scanning protocol.

CLINICAL RELEVANCE/APPLICATION

The wide-detector scanning technique with VHD reconstruction can provide excellent CT attenuation homogeneity which is comparable to standard-detector scanning technique. It will have good potential applications and clinical feasibility for TAG and FFRCT of coronary CT imaging

SST02-04 Analysis of Raw High Speed Myocardial Perfusion SPECT Images by Deep Convolutional Networks Improve Prediction of Potentially Significant Ischemic Defects

Friday, Dec. 1 11:00AM - 11:10AM Room: E450A

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PURPOSE

We aimed to assess the abilities of deep convolutional neural networks (CNN) for automatic prediction of obstructive coronary stenosis from raw fast myocardial perfusion SPECT imaging (MPI) data.

METHOD AND MATERIALS

1468 patients (67% males) undergoing stress-first high speed SPECT in 7 national and international sites were studied. All patients were assessed for obstructive stenosis >= 70% by invasive coronary angiography (ICA). Left ventricular myocardium was segmented using standard Cedars-Sinai Quantitative Perfusion SPECT (QPS) and verified by one expert reader. Stress total perfusion deficit (TPD) was also automatically computed by statistical comparison to normal limits. The CNN approach was evaluated in a stratified 10-fold cross-validation procedure using supine stress raw polarmaps exported from QPS (10° angle resolution), and implemented using the Caffe Deep Learning Framework. CNN comprised three consecutive convolutional units, followed by two dense fully connected layers with a rectified linear unit activation, and a final softmax loss function for the optimization of the network. Area under the curve (AUC) comparison by Delong test was used to compare the performance of the CNN score and TPD to predict potentially significant ischemic defects. Net reclassification improvement (NRI) for TPD at 5% threshold and for the CNN score was also computed. Two-graph ROC technique was used to compute the optimal CNN score cutoff for NRI comparison.

RESULTS

From the total 1468 patients, 882 (60%) had obstructive stenosis >= 70%. 864 (60%) out of 1448 (99%) patients with no suspected coronary artery disease had ICA stenosis. The left ventricular contour assigned by standard QPS was adjusted in 323 (22%) stress images. AUC for CNN score was significantly higher than for stress TPD (0.81 vs 0.78, P<0.01 by Delong test). The optimal CNN score cutoff was found to be 0.7. A net reclassification improvement of 6.6% [95% CI: 2.2%-11%] (P<0.01) was significant for the optimal CNN cutoff as compared to stress TPD at 5%.

CONCLUSION

CNN improved the prediction of potentially significant ischemic defects and has the potential to enhance automatic interpretation of MPI studies. CNN combination of multiple polarmaps and patient information may bring further improvement.

CLINICAL RELEVANCE/APPLICATION

Automatic CNN interpretation of SPECT MPI may provide improved automatic scan interpretation without the needing of normal databases as for TPD.

SST02-05 Evaluation of Coronary Artery Calcium using Dual Energy Chest X-rays: Digital Phantom Study

Friday, Dec. 1 11:10AM - 11:20AM Room: E450A

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PURPOSE

Despite proponents of CT coronary artery calcification (CAC) score, which provides proof of disease and predicts future events, it is not recommended for screening because of cost and radiation. Previously, we have demonstrated ability to identify CAC using 2-shot, dual energy (DE) chest x-rays, giving an opportunity to screen CAC from an already ordered exam. Here we will use digital simulations, backed up by measurements, to characterize DE calcium signals and the role of potential confounds such as beam hardening, xray scatter, cardiac motion, and pulmonary artery pulsation. For the DE calcium signal, we will consider quantification, as compared to CT calcium score, and visualization.

METHOD AND MATERIALS

We created stylized and anatomical digital 3D phantoms which included CAC. We simulated high and low kV x-ray acquisitions with xray spectra, energy dependent attenuation, scatter, ideal detector, and automatic exposure control (AEC). Phantoms allowed us to vary CAC size and density, adipose thickness, cardiac motion, etc. We used specialized dual energy coronary calcium (DECC) processing that includes corrections for scatter, beam hardening, and motion correction.

RESULTS

With DECC processing, beam hardening over a wide range of adipose thickness (0-30 cm) reduced CAC signal (ΔICAC) by <3%. Scatter correction errors of ±50% affected ΔICAC by ±9%. If a simulated pulmonary artery fills with blood between exposures, it can give rise to a residual signal in DECC images, explaining pulmonary artery visibility in some clinical bone images. Residual misregistration can be mostly compensated by integrating signals in an enlarged region encompassing registration artifacts. DECC calcium score compared favorably to CT mass score over a number of phantom perturbations.

CONCLUSION

Simulations indicate that proper DECC processing can faithfully recover coronary calcium signals. Beam hardening, errors in scatter estimation, cardiac motion, calcium residual misregistration, are all manageable. Simulations are valuable as we continue to optimize DE coronary calcium image processing and quantitative analysis.

CLINICAL RELEVANCE/APPLICATION

CAC detection from already ordered chest xrays would give benefits of CT CAC without its costs (patient charge and radiation), and lead to patients' adoption/adherence to lifestyle/drug therapies.

SST02-06 Diagnostic Performance of Computed Tomography Area Measurements of the Suprahepatic Segment of the Inferior Vena Cava to Predict Central Venous Pressure and Mortality in Patients Undergoing Transcatheter Aortic Valve Implantation

Friday, Dec. 1 11:20AM - 11:30AM Room: E450A

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PURPOSE

To evaluate correlation of computed tomography (CT) area measurements of the suprahepatic segment of the inferior vena cava (IVC) with central venous pressure (CVP) and its performance to predict CVP and mortality in patients with severe symptomatic aortic stenosis.

METHOD AND MATERIALS

We retrospectively analyzed 153 consecutive patients (median age 84, 78 females) undergoing transcatheter aortic valve implantation (TAVI) at the University Hospital Zurich between January 2010 and December 2014. Only patients undergoing right heart catheterization (RHC) and CT within 1 consecutive day as part of preinterventional TAVI assessment were included. Patient baseline characteristics and outcome data after one year were recorded. Area measurements of the suprahepatic IVC were performed on axial CT slices. Correlations were assessed with Pearson's correlation coefficient. The optimal cutoff point for IVC area measurements to predict an elevated CVP (>=10mmHg) or mortality was determined using receiver operating characteristics (ROC) analysis.

RESULTS

RHC showed elevated CVP in 34 patients (25%) at baseline. IVC area measurements indicated a moderate correlation with CVP ($r=0.47$; $p<0.001$). For area measurements ROC analysis showed an AUC of 0.77 ($p<0.001$) to predict elevated CVP and an AUC of 0.77 ($p<0.001$) to predict one year mortality. A cutoff of 639mm2 for IVC area had a specificity of 80% and a sensitivity of 64% to predict a CVP >= 10mmHg. Whereas a little higher cutoff of 665mm2 for IVC area showed a specificity of 80% and a sensitivity of 60% to predict one year mortality. Indexing area measurements to body surface area did not lead to better diagnostic performance. Multivariate logistic regression analysis controlling for age, sex, body surface area and logistic EuroSCORE II indicated that an IVC area >= 665mm2 is a significant predictor of one year mortality with an odds ratio of 6.8 (95%CI: 2.2-21.1).

CONCLUSION

Our study suggests that area measurements of the suprahepatic segment of the IVC has the potential to non-invasively predict elevated CVP with moderate sensitivity but good specificity. Furthermore, an enlarged IVC seems to be a predictor of one year mortality in TAVI patients.

CLINICAL RELEVANCE/APPLICATION

Assessing the inferior vena cava to predict central venous pressure is an established method in ultrasound but has not been assessed in CT as a robust and reproducible examination modality, so far.

SST02-07 Lower Annual Cardiac Events in Diabetics with a Normal Exercise GMPI and aFunctional Capacity >=7 METS on Treadmill

Friday, Dec. 1 11:30AM - 11:40AM Room: E450A

Participants
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PURPOSE

Good exercise capacity has a high negative predictive value (NPV) in patients with known or suspected coronary artery disease (CAD) similar to a normal gated myocardial perfusion imaging (GMPI). However, previous studies have suggested that diabetic patients undergoing single photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) are at greater risk for cardiac events than non-diabetic patients with both normal and abnormal MPIs. Aim of this study was to evaluate NPV of functional capacity during treadmill exercise in diabetics with normal GMPI in Pakistani population.

METHOD AND MATERIALS

This was a prospective study which included 338 diabetics with normal exercise GMPI. On the basis of metabolic equivalents (METS) achieved during exercise, these patient were divided into Group A: >=7 METS (140 patients) and Group B: <7METS (198 patients). These patients were followed up on telephone (for 18 ±3 months) for fatal or non-fatal myocardial infarction (FMI and NFMI respectively). Regarding risk factors in Group A and B, like obesity (50 vs. 54%), hypertension (61 vs. 60%), smoking (14 vs. 15%), dyslipidemia (32 vs. 42%) and family history (32 vs. 30%), no significant difference was found.

RESULTS

The mean age predicted HR (MAPHR) achieved in group was significantly higher than Group B (86% vs. 83%). No significant difference was found between LV functional parameters (like ejection fraction, end diastolic and systolic volumes) of two groups. During follow up period, the overall all cardiac events reported in Group A was 03 (all NFMI and no FMI) while in Group B 16 events (15 NFMI and 01 FMI) were reported. Annualized event rate for overall events, NFMI and FMI in two groups were 1.43 vs. 5.39%, 1.43 vs. 5.05 and 0% vs. 0.3% respectively.

CONCLUSION

We conclude that NPV of a normal GMPI is higher in diabetic patients with a functional capacity >=7 METS than their counterparts who could achieve <7 METS on treadmill.

CLINICAL RELEVANCE/APPLICATION

Gated MPI has comparable diagnostic accuracy for CAD in diabetics but its prognostic strength is very high. Effort tolerance >7 METS with a negative MPI enhances the NPV in diabetics who are found to have high event rate despite of a normal MPI with vasoldilator or worklaod <7 METS

SST02-08 Increased Epicardial Fat Volume is Related to Diabetes Mellitus, Early Subclinical Atherosclerosis and Serum Levels of Inflammatory Biomarkers in Asymptomatic Patients

Friday, Dec. 1 11:40AM - 11:50AM Room: E450A

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PURPOSE

We aimed to investigate whether increased epicardial fat volume (EFV) is related to inflammatory serum biomarkers, diabetes mellitus (DM) and early atherosclerosic disease in asymptomatic patients.

METHOD AND MATERIALS

We evaluated 456 asymptomatic patients from the EISNER (Early Identification of Subclinical Atherosclerosis using Non-invasivE Imaging Research) registry. EFV was quantified using semi-automated QFAT version 2.0 software from non-contrast CT data sets. EFV was assessed in patients with a coronary calcium score (CCS) of 0, early atherosclerosis (CCS 1-99) and advanced atherosclerosis (CCS >=100). EFV was examined in relation to CCS, serum levels of inflammatory biomarkers and presence of DM.

RESULTS

Mean EFV was lowest in 144 patients with a CCS of 0 [74 cm^3, interquartile range (IQR): 53-91] and was significantly higher in 144 patients with early atherosclerosis [87 cm^3, IQR: 56-111, p=0.016] and in 168 subjects with advanced atherosclerosis [89 cm^3, IQR: 61-112, p=0.002]. In multivariable analysis, log-transformed EFV was strongly associated with DM [Odds Ratio (OR) 4.6 (95% CI: 2.1-9.8), p<0.001], over hypertension (p=0.023), family history of coronary artery disease (CAD) (p=0.026), CCS (p=0.042) or other risk factors (p>0.05). EFV was correlated with serum biomarkers endothelial plasminogen activator inhibitor 1 (PAI-1) (r=0.29, p<0.001), monocyte chemoattractant protein 1 (MCP-1) (r=0.20, p<0.001), vascular cell adhesion molecule 1 (VCAM-1) (r=0.12, p=0.026) and inversely correlated with adiponectin (r=-0.18, p<0.001), while CCS was not correlated with serum levels of biomarkers (p>0.05). In multivariate regression analysis adjusted for age, cardiovascular risk factors and CCS EFV remained independently associated with PAI-1, MCP-1 and VCAM-1 (all p<0.05).

CONCLUSION

EFV is significantly increased in patients with coronary calcium compared to those with a CCS of 0; with no significant differences in patients with early atherosclerosis or advanced atherosclerosis. Increased EFV is associated with DM and serum levels of inflammatory biomarkers, suggesting that it may be linked to early plaque formation, metabolic abnormality and plaque inflammation.

CLINICAL RELEVANCE/APPLICATION

As a metabolically active fat depot increased epicardial fat volume predicts adverse cardiac events, however, its relationship to early coronary atherosclerosis, inflammatory biomarkers and diabetes mellitus remains unknown.

RSNA 2017 Explore. Invent. Transform.
103rd Scientific Assembly and Annual Meeting
November 26 to December 1
McCormick Place, Chicago
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SST03

Chest (Functional Lung Imaging/Radiation Dose Reduction)

Friday, Dec. 1 10:30AM - 12:00PM Room: E451B

CH CT MR SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SST03-01 Measuring Specific Ventilation using Four-dimensional Magnetic Resonance Ventilation Imaging: A Novel Physiological Biomarker of Asthma

Friday, Dec. 1 10:30AM - 10:40AM Room: E451B

Awards
Trainee Research Prize - Resident

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PURPOSE

Specific ventilation (SV) is defined as a dimensionless quantity of inhaled gas ventilation that occurs during tidal breathing and is calculated as tidal volume divided by functional residual capacity (Lewis *et al*, 1978). 1H MRI was previously proposed to regionally quantify SV, using inhaled O2 as a contrast agent (Sa *et al*, 2010). Our objective was to develop a novel and rapid way to measure whole lung and regional SV using free-breathing 1H MRI without exogenous contrast agents and over a short tidal breathing scan using conventional equipment. We also aimed to directly compare 1H MRI SV with hyperpolarized inhaled noble gas MRI ventilation and ventilation percent (VP).

METHOD AND MATERIALS

We evaluated 10 asthmatics (50±12yrs) and two healthy volunteers (27±6yrs) who provided written informed consent to MRI, spirometry and whole body plethysmography. Pulmonary hyperpolarized noble gas MRI (Kirby *et al*, 2012) and dynamic 2D multi-slice, whole lung coverage, free tidal-breathing 1H MRI using a bSSFP sequence (Capaldi *et al*, 2015) were acquired on a 3T system (GEHC). Free-breathing 1H MRI was retrospectively gated to generate tidal inspiration/expiration lung volumes that were co-registered using optical flow deformable registration (Lucas *et al*, 1981). 4DMRI SV maps were generated on a voxel-by-voxel basis using the co-registered volumes to generate local SV distribution maps. MRI ventilation percent (VP=ventilation volume normalized to thoracic cavity volume) and whole lung mean 4DMRI specific ventilation were determined and compared using Pearson correlation coefficients (r).

RESULTS

In Figure 1, 4DMRI SV and 3He MRI for an asthmatic (27yr female FEV1=74%pred, SV=0.08, VP=97.4%) shows qualitative agreement in the right-upper-lobe. For all subjects, there was a significant relationship for MRI specific ventilation and inhaled noble gas MRI ventilation percent (r=.67, p=.02), FEV1/FVC (r=.74, p=.007) and plethysmography SV (r=.77, p=.003).

CONCLUSION

In asthmatics, 4DMRI ventilation defects were spatially related with hyperpolarized inhaled noble gas MRI ventilation defects; 4DMRI SV also strongly correlated with experimentally measured SV and inhaled gas MRI ventilation percent.

CLINICAL RELEVANCE/APPLICATION

Free-breathing 4DMRI was exploited to generate specific ventilation maps that strongly correlated with experimentally acquired specific ventilation and inhaled noble gas MRI ventilation percent.

SST03-02 Preoperative Assessment of Localized Pleural Adhesion: Utility of Software-Assisted Analysis on 4-Dimensional Ultra-Low-Dose CT (4D-ULDCT)

Friday, Dec. 1 10:40AM - 10:50AM Room: E451B

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PURPOSE

To assess the usefulness of software analysis using 4-dimensional ultra-low-dose CT (4D-ULDCT) for localized pleural adhesion (LPA).

METHOD AND MATERIALS

Twenty-four consecutive patients scheduled to undergo surgery underwent both 4D-ULDCT during a single respiration and conventional high-resolution chest CT as preoperative assessments. Four radiologists, who were blinded to patient status, independently evaluated the presence and severity of LPA in 3 grading-scale (non-LPA, mild LPA and severe LPA) for 6 measurement points (MPs) (upper and lower area on ventral, lateral and dorsal aspects) on the chest CT by 2 different methods: (i) observing conventional high-resolution CT images (static), reconstructed in the axial, coronal, and sagittal directions; (ii) observing 4D-ULDCT images (movie), while another radiologist similarly evaluated the presence and severity of LPA by the other method: (iii) observing adhesion map (A-map), which is colored gradient map created by research software using 4D-ULDCT that suggested the absence/presence of LPA based on the difference in the movements between the lung surface and chest wall. The presence and severity of LPA was confirmed in an identical fusion by their intraoperative thoracoscopic findings. Diagnostic accuracy in 3 grade scaling and the LPA presence were conducted between (i) and (iii), between (ii) and (iii) using t-test for a single sample, and between (ii) and (iii) using Wilcoxon signed-rank test.

RESULTS

The presence of LPA was surgically confirmed on 23MPs in 8 patients: 20MPs with mild LPA, 3MPs with severe LPA. For the LPA assessment, A-map method (iii) achieved significant better diagnostic performance with higher accuracy in 3-grade scaling of 78.5%, and higher sensitivity of 73.9%, PPV of 44.7% and NPV of 94.3%, comparable specificity of 82.6% for the LPA presence, in comparison with the other methods ((i), (ii)) ($p<0.05$). No significant difference in diagnostic performance were showed between conventional CT (i) and 4D-ULDCT (ii) ($p >0.05$)

CONCLUSION

Four-D ULDCT in combination with A-map method could be useful as a novel imaging approach for accurate preoperative analysis of LPA.

CLINICAL RELEVANCE/APPLICATION

This is the first study to demonstrate the clinical usefulness of software-aided, 4D-ULDCT images for the preoperative diagnosis of the presence and severity of LPA.

SST03-03 Quantification of Lung Perfusion and Ventilation in Patients with Chronic Thromboembolic Pulmonary Hypertension (CTEPH) Before and After Pulmonary Endarterectomy Using Phase Resolved Fourier Decomposition MRI

Friday, Dec. 1 10:50AM - 11:00AM Room: E451B

Participants
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PURPOSE

To evaluate Fourier decomposition (FD) imaging of the lung as a radiation free, non-contrast-enhanced method for detection of perfusion and ventilation changes in CTEPH patients before and after pulmonary endarterectomy (PEA).

METHOD AND MATERIALS

We investigated 27 patients with diagnosed CTEPH before and 2 weeks after PEA. All patients underwent DCE time-resolved angiography with stochastic trajectories (TWIST) in one breathhold and a 2D fast low-angle shot (FLASH) sequence in free breathing in supine position, on a 1.5 T MRI. Coronal acquisition of FD imaging of the lung was performed. After nonrigid image registration (ANTS), and manual segmentation, perfusion and ventilation maps were generated using a image-sorting algorithm.

Histograms were calculated to visualize the distribution of ventilation and perfusion. Ventilated, but not perfused lung voxels were defined as perfusion defect, perfused, but not ventilated lung voxels were classified as ventilation defect.

RESULTS

Using DCE MRI as reference, the median PBF increased from 30,1ml/min/100ml (25-75% quartile range: 26-50) to 54,5ml/min/100ml (25-75 quartile range: 49-71, p<0,0001). Using FD MRI, the median perfusion defect percentage of the whole lung decreased from 46% (25-75% quartile range: 39-50%) to 33% (25%-75% quartile range: 27 -39%) after PEA (p<0.0001). The ventilation defect percentage of the whole lung was minimal and did not change (pre and post procedural median: 1% (25-75% quartile range: 0-3%). There was a significant difference of the perfusion defect percentage in the right lower lobe (median: pre 42%, median post: 17%, p<0,0001), the right upper lobe (median: pre 53%, median post: 28%, p=0.0005) and in the middle lobe (median: pre 46%, median post: 25%, p=0.0002). No significant difference of perfusion defect percentage was observed in the left lower (median: pre 48%, median post: 52%, p=0.48) and upper (median: pre 35%, median post: 41%, p=0.13) lobes.

CONCLUSION

Phase resolved Fourier Decomposition MRI is a feasible method to monitor regional ventilation and perfusion in CTEPH patients pre and post PEA. Especially left lower lobe results may be influenced by cardiac motion, which could interfere with the phase measurements of the parenchymal blood flow.

CLINICAL RELEVANCE/APPLICATION

These promising results may enable a proton-based, radiation and contrast free monitoring option of therapeutic effects after PEA in CTEPH patients in the future.

SST03-04 Blood Volume-Based MR Imaging with Ultra-Short TE vs Quantitatively and Qualitatively Assessed CT vs Perfusion SPECT: Capability for Prediction of Postoperative Lung Function in Non-Small Cell Lung Cancer Patients

Friday, Dec. 1 11:00AM - 11:10AM Room: E451B

Participants
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PURPOSE

To directly compare the capability of contrast-enhanced (CE-) pulmonary thin-section MR imaging with ultra-short TE (UTE) as semi-quantitatively assessed blood-volume based MR imaging (BV-MRI with UTE) for prediction of postoperative lung function in non-small cell lung cancer (NSCLC) patients as compared with quantitatively and qualitatively assessed CT and perfusion SPECT.

METHOD AND MATERIALS

29 NSCLC patients (16 men and 13 women) underwent unenhanced and contrast-enhanced pulmonary thin-section MR imaging with UTE at a 3T system, thin-section CT, perfusion SPECT, and measurements of FEV1% before and after lung resection. In each patient, BV MRI was generated as percent signal change between unenhanced and CE-pulmonary thin-section MR imaging by pixel-by-pixel analyses after non-rigid registration. On BV-MRI with UTE, postoperative FEV1% (poFEV1%) was predicted from semi-quantitatively assessed blood volumes within total and resected lungs. Quantitatively predicted poFEV1% using CT was determined from the functional lung volumes within total and resected lungs by commercially available software. Qualitatively predicted poFEV1% using CT was determined from the number of segments of total and resected lungs. On perfusion SPECT, poFEV1% was predicted from uptakes within total and resected lungs. Then, each predicted poFEV1% was correlated with actual poFEV1%, and the limits of agreement between actual and each predicted poFEV1% were also evaluated by Bland-Altman analysis.

RESULTS

poFEV1%s predicted by BV-MRI with UTE (r=0.82, p<0.0001) and quantitative CT (r=0.86, p<0.0001) had better correlation with actual poFEV1%, when compared with qualitatively assessed CT (r=0.79, p<0.0001) and SPECT (r=0.78, p<0.0001). The limits of agreement between predicted and actual poFEV1% by BV-MRI with UTE (4.3±12.7 %) and quantitatively assessed CT (3.5±10.8 %) were smaller than those by qualitatively assessed CT (5.1±13.9 %) and SPECT (4.2±14.5 %).

CONCLUSION

BV-MRI with UTE can more accurately predict postoperative lung function than qualitatively assessed CT and perfusion SPECT, and is at least as valuable as quantitatively assessed CT in NSCLC patients.

CLINICAL RELEVANCE/APPLICATION

Blood volume-based MRI with UTE can more accurately predict postoperative lung function than qualitatively assessed CT and perfusion SPECT, and is at least as valuable as quantitatively assessed CT in NSCLC patients.

SST03-05 Correlation between Diaphragmatic Excursion and Decrease in Lung Volume on Expiratory Phase Imaging in Asthma Patients

Friday, Dec. 1 11:10AM - 11:20AM Room: E451B

Awards
Student Travel Stipend Award

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PURPOSE

Inspiratory and expiratory phase imaging is often requested in asthma patients to evaluate air trapping, however, there is no radiographic measure of optimal expiration. Diaphragmatic excursion may be a reliable surrogate for lung volume assessment to gauge adequacy of expiration, particularly as the trachea may not change in configuration despite decrease in tracheal and/or lung volume.

METHOD AND MATERIALS

Between January 1, 2016 and December 31, 2016, a total of 226 CT exams with inspiratory and expiratory phase imaging were performed, 63 in individuals with asthma. Patients with supine imaging acquired with the same parameters in each phase were included (n= 33, mean age = 62, M=15, F=15). Diaphragmatic excursion was calculated as the difference between axial slices through the lungs on inspiration and expiration, using the lung apex and the cranial bound and diaphragm caudally. Lung and tracheal volumes were measured for each patient at inspiration and expiration.

RESULTS

Average inspiratory (I) and expiratory (E) lung volume was greater for men (I=5007 mL, E=3122 mL) than women (I=3122mL, E=1503mL). Similarly, average tracheal volumes were higher in men (I=61mL, E=45) than women (I=44, E=30). Average change in lung volume was 1500mL (range -564mL to 4109mL). Diaphragmatic excursion was found to range from -0.6cm to 6.8cm, with an average change in diaphragmatic excursion of 2.5 cm between inspiratory and expiratory scans (2.3 cm in women, and 2.7 cm in men). There was a very strong positive correlation between diaphragmatic excursion and change in lung volume between inspiratory and expiratory scans (r=0.83), and strong positive correlation with change in tracheal volume (r=0.79). A strong correlation was also found between change in tracheal volume and change in lung volume (r=0.67).

CONCLUSION

Diaphragmatic excursion is a strong quantitative measure of actual expiratory effort as validated by both lung and tracheal volumes, and may be more reliable than qualitative features such as tracheal morphology.

CLINICAL RELEVANCE/APPLICATION

Diaphragmatic excursion is a reliable quantitative surrogate for lung volume, and is an easily applicable clinical tool to assess the adequacy of expiratory phase image acquisition.

SST03-06 Pulmonary Function Diagnosis Based On Temporal Changes in Lung Density with Dynamic Flat-Panel Detector (FPD) Imaging: An Animal-Based Study

Friday, Dec. 1 11:20AM - 11:30AM Room: E451B

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PURPOSE

X-ray translucency of the lungs changes with respiration. This is caused by relative increases and decreases in the volume of the lung vessels and bronchi per unit lung volume; pulmonary function can be evaluated based on temporal changes in the image density of the lung regions. The aim of the present study was to investigate the diagnostic performance of dynamic chest radiography for pulmonary function diagnosis based on respiratory changes in lung density.

METHOD AND MATERIALS

Sequential chest radiographs of six domestic pigs (body weight ca. 20-30 kg) were obtained during respiration using a dynamic flat-panel detector system (100 kV; 0.25 mAs/pulse; 15 frames/s; Test model, Konica Minolta). The pigs were intubated under

anesthesia, and respiratory control was ensured with a ventilator (100, 200, 300, 400, and 500 mL). We created porcine models of atelectasis using a catheter procedure, and analyzed the correlation between the inspired volume and changes in the pixel value measured in the lungs. To facilitate visual evaluation, differences in pixel values between an image taken at maximum expiration and those during respiration were sequentially calculated and then superimposed on the original images as a color display, employing a color table in which higher X-ray translucency (increased air) is shown in cold colors, creating functionally colored images.

RESULTS

Average pixel values in the lung regions changed according to forced respiration. High linearity was seen between changes in pixel value and inspired volume ($r = 0.9$). Changes in pixel value related to the inspired volume were successfully visualized as changes in color intensity on the functional colored images. In addition, areas of atelectasis were revealed as decreased changes in pixel values. Trapped air and airflow restriction were detected as higher and lower color intensity on functionally colored images, respectively (Fig. 1).

CONCLUSION

Dynamic chest radiography allowed for the evaluation of pulmonary function based on temporal changes in lung tissue image density. Inspired volume is quantified as changes in pixel value, and ventilation defects are detected as reduced changes in pixel value even without the use of contrast media.

CLINICAL RELEVANCE/APPLICATION

The method presented here is a simple and cost-effective functional imaging technique that can be performed as an adjunctive examination for conventional chest radiography.

SST03-07 CT Measurement of Atrioesophageal Adipose Tissue and Correlation with Metabolic Syndrome: Preliminary Results

Friday, Dec. 1 11:30AM - 11:40AM Room: E451B

Participants
Dennis P. Gilroy, DO, Rochester, NY (*Presenter*) Nothing to Disclose
Hakan Sahin, MD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Epicardial adipose tissue measurements on cardiac imaging planes have demonstrated association with atrial fibrillation and coronary artery disease. We wanted to investigate the utility of adipose measurements between the left atrium and esophagus on conventional axial and sagittal planes of routine chest CTs performed with ECG-gating in predicting the presence/complications of metabolic syndrome.

METHOD AND MATERIALS

The study protocol has been approved by the IRB. In this preliminary analysis, 50 patients with cardiac-gated CT performed for cardiac morphology or suspected aortic dissection were included, prospectively recorded, and retrospectively analyzed. The size of the atrioesophageal adipose tissue was measured on axial and sagittal images. Clinical conditions associated with metabolic syndrome were also recorded (hypertension, diabetes mellitus, BMI, dyslipidemia and atrial fibrillation). The association between the size of the adipose tissue and the clinical conditions was investigated.

RESULTS

Preliminary analysis reveals statistically significantly larger atrioesophageal fat in patients with dyslipidemia, compared with those who did not (p value 0.006). Additionally, this relationship extends to those with elevated systolic blood pressure (p value 0.05). The optimal threshold within the atrioesophageal fat measurement was determined to be greater than 4.1 mm in the sagittal plane (72.7% sensitivity and 62.5% specificity for the presence of dyslipidemia). Additional correlation exists between the axial measurement of atrioesophageal fat and BMI, albeit not statistically significant with the current data.

CONCLUSION

CT based epicardial fat quantification, using conventional imaging planes, is a simple tool that can be applied in everyday practice to identify patients with components of metabolic syndrome and possibly predict complications. While these results are preliminary, it is felt that the correlation between atrioesophageal fat measurement and additional various clinical parameters of metabolic syndrome will exist at statistically significant levels with a larger population.

CLINICAL RELEVANCE/APPLICATION

CT-based identification of patients with metabolic syndrome during routine CT evaluation using conventional imaging planes can serve as a value-added service leading to prediction of complications such as atrial fibrillation and alter therapeutic management due to known subsequent recurrence.

SST03-08 Effect of New Model-Based Iterative Reconstruction on Computer-Aided Detection for Quantitative Analysis of Airway Tree in Low-Dose Chest CT: Comparison with Adaptive Statistical Iterative Reconstruction in Routine Dose

Friday, Dec. 1 11:40AM - 11:50AM Room: E451B

Participants
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PURPOSE

To evaluate the new model-based iterative reconstruction (MBIRn) with balanced setting (MBIRSTND) and spatial resolution preference (MBIRRP20) and adaptive statistical iterative reconstruction (ASIR) in low-dose and ASIR in routine dose on the performance of computer-aided detection (CAD) for quantitative airway analysis.

METHOD AND MATERIALS

30 patients had follow up scan for pulmonary disease on a GE Discovery CT750 HD system. Image acquisition was performed at routine dose and reduced dose level by increasing noise index (NI) from 14HU to 28HU using automatic tube current modulation. Tube voltage was fixed at 120kVp. Data of routine dose were reconstructed with ASIR, while low-dose were reconstructed with ASIR, MBIRSTND and MBIRRP20. Airway dimensions measured from the four reconstructions using an automated, quantitative software that was designed to segment and quantify the bronchial tree, and a skeletonization algorithm to extract the center-line of airway trees automatically (Figure 1). For each patients and reconstruction algorithm chose the right middle lobe bronchus with the least tortuous and bifurcation to measure the bronchial length of the matched airways. Two radiologists used a semi-quantitative 5-point scale (-2: inferior; 0, equal to ASIR in routine dose; 2: superior) to rate subjective image quality of airway trees on the low-dose images reconstructed with ASIR and MBIRn. Using paired t and Wilcoxon signed-rank tests for comparison.

RESULTS

Median effective dose was 3.01±1.89mSv at routine dose and 0.88±0.83mSv at 71% dose reduction. Algorithm impacts the measurement variability of the length of bronchus in low-dose chest CT, and MBIRSTND and MBIRRP20 were better than ASIR for the airway trees, while MBIRSTND displayed longer bronchus than ASIR in routine dose ($P<0.05$) (Table 1,Figure 2). MBIRSTND for the low dose chest CT also had higher subjective scores for the airway trees than ASIR in routine dose (Table 2,Figure 2).

CONCLUSION

The quantification accuracy of airway is strongly influenced by reconstructions. MBIRSTND and MBIRRP20 algorithms allow the desired airway quantification accuracy of CAD for chest to be achieved for 71% radiation dose reduction.

CLINICAL RELEVANCE/APPLICATION

Compare ASIR,MBIRSTND and MBIRRP20 from MBIRn algorithm potentially allows the desired airway quantification accuracy to be achieved on the performance of CAD with low-dose chest CT, especially for MBIRSTND.

SST03-09 Modified CT Fluoroscopy-Guided Lung Nodule Biopsy versus Conventional CT-Guided Biopsy: A Prospective Controlled Study to Assess Radiation Doses and Complication Rate

Friday, Dec. 1 11:50AM - 12:00PM Room: E451B

Participants
Ting Liang, Xian, China (*Presenter*) Nothing to Disclose
Gang Niu, MD, Xian, China (*Abstract Co-Author*) Nothing to Disclose
Jin Shang, Xian, China (*Abstract Co-Author*) Nothing to Disclose
Jian Yang, MD, PhD, Xian, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The aim of the study was to evaluate complication rate and radiation doses of lung nodule biopsy by the CT modified fluoroscopy-guided and conventional CT-guided methods.

METHOD AND MATERIALS

A total of 100 patients in single radiology unit were prospectively enrolled to receive CT-guided lung biopsy. 50 patients were undergoing modified CT fluoroscopy-guided (CTF) biopsy (Group 1), and other half was checked by traditional CT-guided methods (Group 2). The modified biopsy plan referred to the method of using axial scan with step by step for the nodule. 2 experienced chest radiologists performing thoracic biopsies performed CT-guided biopsy. 64 slice spiral CT (Toshiba) were performed with CT-guided pulmonary biopsy with the Japan 16G cutting biopsy needle. Radiation dose and diagnostic accuracy of patient were outcome measurements. Differences between proportions were analyzed with the chi-square test. Dose-length product (DLP) was compared between 2 groups. Sensitivity, specificity and accuracy were calculated based on 80 patient's results.

RESULTS

There were no significant between the two groups for the pulmonary nodules characteristics : size, group 1: 34±18mm (mean±standard deviation) vs. group 2: 38±20 mm ($p=0.845$); depth from pleura, 13±12 mm vs. 12±9 mm ($p=0.595$) (Table 1). The total DLP of the study group (median 3.8 mSv) was significantly reduced compared to that of the comparison group (median 11.1 mSv, p?0.05).

CONCLUSION

CT modified fluoroscopy-guided lung nodule biopsy provides high diagnostic accuracy and more lower radiation doses compared to conventional methods, and may be alternatively used for appropriate lung nodule.

CLINICAL RELEVANCE/APPLICATION

The CT modified fluoroscopy-guided pulmonary biopsy which can significant reduce the radiation dose and complication rate should be selected in clinical practice.

SST04

Science Session with Keynote: Gastrointestinal (Hepato-Biliary Imaging)

Friday, Dec. 1 10:30AM - 12:00PM Room: E353B

CT GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Aliya Qayyum, MBBS, Houston, TX (*Moderator*) Spouse, Founder, In Context Reporting
Shahid M. Hussain, MD,PhD, Omaha, NE (*Moderator*) Nothing to Disclose
David D. Bates, MD, Boston, MA (*Moderator*) Director, Imaginglink Inc

Sub-Events

SST04-01 Gastrointestinal Keynote Speaker: What is New and Hot in Hepato Biliary MR imaging

Friday, Dec. 1 10:30AM - 10:40AM Room: E353B

Participants
Shahid M. Hussain, MD,PhD, Omaha, NE (*Presenter*) Nothing to Disclose

SST04-02 Utility of Longitudinal Measurement of the Liver on Ultrasound in Comparison to CT Liver Volume in Assessing Hepatomegaly

Friday, Dec. 1 10:40AM - 10:50AM Room: E353B

Awards
Student Travel Stipend Award

Participants
Devaki Shilpa S. Surasi, MD, MBBS, Oklahoma City, OK (*Presenter*) Nothing to Disclose
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PURPOSE

The purpose of the study is to retrospectively compare the longitudinal measurement of the liver on ultrasound (US) with liver volume as measured on CT.

METHOD AND MATERIALS

This IRB approved retrospective study with prospective image analysis included adult patients with US examinations of the liver or abdomen and CT examinations of the abdomen or abdomen/pelvis performed within 2 weeks of each other from 1/1/2010 to 4/30/2016. We recorded the longitudinal length measurement of the right lobe of the liver on the US study. The liver volume was calculated using manual 3D segmentation (AW suite). Hepatomegaly was defined as a liver volume of 2000 cc or greater. SPSS software was used for statistical analysis which included Receiver operating characteristic curve (ROC) analysis.

RESULTS

The sample had 130 patients including 64 males and 66 females. Liver length measured on US had a moderate positive correlation with liver volume measured on CT, with a Pearson correlation coefficient of 0.71. ROC curve was generated with area under the curve (AUC) of 0.78 (95% CI of 0.70-0.86/Standard error of 0.04). Based on this, an US cutoff of 16.4 cm was found to be an optimal threshold to identify hepatomegaly. Using this cutoff, the sensitivity for hepatomegaly was 83.3% (95% CI of 71.3 - 91%) and the specificity was 63.2% (51.9% - 73.1%). Using a maximum ultrasound liver length of 17 cm, the sensitivity for hepatomegaly was 81.5% (95% CI of 69.7% - 90.3%) and the specificity was 76.3% (65.6% - 84.5%). Using a maximum ultrasound liver length of 18 cm, the sensitivity was 63.0% (49.6%-74.6%) and the specificity was 84.2% (74.4% - 90.7%).

CONCLUSION

Liver length measured with US has only a moderate correlation with liver volume. Commonly used US liver length maximum values of 17 cm and 18 cm produce a significant number of false negatives and false positives. US length of 16.4 cm was found to be an optimal threshold to identify hepatomegaly. Improved methods for measuring liver size with US are needed.

CLINICAL RELEVANCE/APPLICATION

There is only a moderate correlation between liver length measured with US and liver volume measured on volumetric CT, potentially resulting in incorrect liver size estimates with US.

SST04-03 Acute Cholecystitis: Implications of Ultrasound Findings on Surgical and Clinical Outcomes

Friday, Dec. 1 10:50AM - 11:00AM Room: E353B

Participants
Daniel Van Roekel, MD, Boston, MA (*Presenter*) Nothing to Disclose
Christina A. LeBedis, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Jeffrey Santos, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Deepan Paul, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To identify sonographic signs of acute cholecystitis that predict surgical and clinical outcomes.

METHOD AND MATERIALS

The Institutional Review Board approved this HIPAA-compliant retrospective study. Informed consent was waived. 380 patients who underwent cholecystectomy between 06/22/2014 and 03/01/2016 and received abdominal ultrasound (US) prior to surgery were included. Individual US signs, including the presence of stones, gallbladder distention (> 4 cm transverse or > 10 cm long), wall thickening (> 3 mm), pericholecystic fluid, and abscess were graded in a blinded fashion. Outcomes included operating room (OR) duration, drain placement, surgical pathology, bile leak and surgical site infection. The US signs and outcomes were analyzed using an ANOVA or Chi square test.

RESULTS

Of 380 patients, 366 had documented OR times, of which 155 showed gallbladder distention on US. Patients with distention had increased OR times (22.7 minutes longer, p< 0.0001), increased rate of partial cholecystectomy (odds ratio 5.9, 95% CI: 1.22 to 28.01; p= 0.0192), surgical drain placement (odds ratio 2.7; 95% CI: 1.278-5.629, p=0.0071) and pathology diagnosis of acute and chronic cholecystitis (odds ratio 4.3; 95 % CI: 2.60 to 7.12, p <0.001) when compared with the non-distended group. Of 380 patients, 144 showed wall thickening. Patients with wall thickening had increased OR times (18.7 minutes longer, p=0.0008), increased rate of partial cholecystectomy (odds ratio 4.0; 95 % CI: 1.01 to 15.60, p=0.0455), drain placement (odds ratio 3.2; 95% CI 1.52-6.70, p =0.0014), and pathology diagnosis of acute and chronic cholecystitis (odds ratio 2.7, 95 % CI: 1.66 to 4.35, p <0.0001) than the group with normal wall thickness. US findings including gallstones, pericholecystic fluid and abscess were not positively associated with any of the studied clinical outcomes. Likewise, bile leak, site infection and pathology diagnosis of acute or chronic cholecystitis did not show a positive association with any of the US parameters.

CONCLUSION

Gallbladder distention and wall thickening on US are predictive of extended operating room times, partial cholecystectomy and surgical drain placement in patients presenting with acute cholecystitis.

CLINICAL RELEVANCE/APPLICATION

Gallbladder distention and wall thickening are important sonographic findings that can help the surgeon to predict difficult cholecystectomy cases.

SST04-04 Improved Detection of Small Liver Metastases Located Adjacent to Vessels Using Single Shot 2-Dimensional (2D) Magnetization-Prepared Gradient-Echo (MPGRE) Images Acquired at Hepatocytic Phase (HP) of Liver-Specific Contrast Agent (LSCA)

Friday, Dec. 1 11:00AM - 11:10AM Room: E353B

Awards
Student Travel Stipend Award

Participants
Arthur J. Pesch III, MD, Charlottesville, VA (*Presenter*) Nothing to Disclose
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PURPOSE

MRI with LSCA (Gadoxetic-Disodium, Gd-EOB-DTPA) performed 20-40 mins after intravenous administration has become the standard for assessing liver metastases. Image acquisition is typically done with a 3D fat saturated gradient echo (FSGRE) technique. At HP metastases display low signal intensity (SI) and are well seen against the high SI liver background. Since vessels also display low SI, detection of small lesions may be difficult, particularly when adjacent to vessels. MPGRE, also known as TurboFLASH (Siemens), IR FSPGR (GE), or TFE (Philips), with use of a slice selective MP pulse, provides high SI of the vessels from inflowing unsaturated blood. The goal was to investigate the use of HP-MPGRE for improved lesion detection, especially those adjacent to vessels.

METHOD AND MATERIALS

Thirty-eight consecutive patients with known liver metastases had HP FSGRE (3mm slice thickness) and MPGRE (4mm) at 20 min after LSCA dosing; 23 were imaged at 1.5T and 15 at 3T. Regions of interest were drawn in each case to measure the signal of the largest lesion, the normal liver tissue while avoiding the major vessels, the inferior vena cava representative of vessels, and the

background noise. Contrast-to-noise ratios (CNR) were calculated using the formula (S1-S2)/SD, where S1 was the SI of tissue 1, S2 the SI for tissue 2, and SD the standard deviation of background noise.

RESULTS

Mean (SD) lesion/vessel CNR for the 23 cases imaged at 1.5T and the 15 at 3T were -61.2 (24.4) and -169.3 (75.9) for MPGRE, and 5.3 (53.4) and -9.6 (11.3) for FSGRE, respectively, which, in absolute value, was greater for the former technique than the latter ($p<0.05$ for both). Mean (SD) lesion/liver CNR for the 23 at 1.5T and the 15 at 3T were 24.4 (18.7) and 51.2 (52.2), and 43.8 (18.9) and 60.2 (21.4), respectively, which is greater for the latter than the former ($p<0.05$ for both). While both MPGRE and FSGRE yielded high CNR for lesions compared to liver, only MPGRE provided consistently high CNR for lesions compared to vessels.

CONCLUSION

Lesion/vessel CNR on HP-LSCA-enhanced MRI was significantly and substantially greater for MPGRE than FSGRE, indicating visualization of liver metastases adjacent to vessels was markedly improved using the former technique.

CLINICAL RELEVANCE/APPLICATION

The addition of HP-MPGRE in a LSCA-enhanced liver metastasis MRI protocol is recommended as it markedly facilitates the detection of lesions, particularly those adjacent to vessels.

SST04-05 Abbreviated Liver-MRI vs Full Protocol Liver-MRI Including Hepatobiliary Phase Imaging to Screen for Liver Metastases in Patients with Solid Tumors: Preliminary Results

Friday, Dec. 1 11:10AM - 11:20AM Room: E353B

Participants
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PURPOSE

To investigate whether an abbreviated liver-MRI protocol (AP), consisting of axial T2w-TSE, DWI and pre-contrast T1w-GRE in- and opposed phase (IP/OP) is appropriate to detect and classify liver metastases.

METHOD AND MATERIALS

Ongoing reader study on so far 71 consecutive patients with solid tumors who underwent liver-MRI to search for metastatic disease. All patients underwent a standardized full protocol (FP) hepatic MRI at 1.5T with axial and coronal T2w-TSE ± fat-saturation (fs), axial T1w-GRE (IP/OP), axial and coronal DWI (b=0, 50, 800), multi-phase T1w-dynamic GRE before and after i.v. gadoxetate disodium, and axial T1w-GRE + fs in the hepatobiliary phase. Body radiologists with between 9 and 12 years of experience first reviewed only the abbreviated protocol, and made their diagnosis regarding the presence or absence of focal liver lesions, as well as to the likelihood of malignancy on a 5-point scale. Results of the full MRI-protocol as well as imaging follow-up or histopathology of liver lesion was used as ground truth.

RESULTS

Acquisition time for the AP was 10.3 min., vs 39.8 min. for the FP. Based on the interpretation of the AP images, reader 1 identified all 56 patients with focal liver lesions that were also identified by reading images of the FP; reader 2 identified 54 of the 55 patients with focal liver lesions identified by the respective FP readings. Accordingly, the sensitivity to identify patients with focal liver lesions based on the AP- vs. the FP-readings was 100% (for reader 1) and 98.2% (for reader 2). Regarding characterization of focal liver lesions (positive predictive value), reader 1 had one additional false-positive diagnosis with AP compared to FP, for a PPV of 92% vs.. 94% (35/38 vs. 34/36); 95%-CI: 79 %-98 % vs 81% -99%. Reader 2 had 3 additional false-positive diagnoses with AP vs. FP, for a PPV of 88% vs. 97% (30/34 vs. 33/34); CI: 73%-97% vs. 85%-100%). Average time to read the AP was 43sec. for reader 1 and 72sec. for reader 2.

CONCLUSION

An MRI acquisition time of 10.3 min. and a reading time between 43 and 72 sec. is sufficient to identify patients with malignant focal liver lesions; it offers identical sensitivity and similar specificity and PPV as does a full, dynamic contrast enhanced liver MRI protocol that included hepatobiliary phase imaging.

CLINICAL RELEVANCE/APPLICATION

Abbreviated liver MRI seems useful to allow fast MRI-screening for metastatic spread to the liver in cancer patients.

SST04-06 Diagnostic Performance of an Abbreviated Gadoxetic Acid-Enhanced MRI Protocol for Colorectal Cancer Liver Metastases Surveillance

Friday, Dec. 1 11:20AM - 11:30AM Room: E353B

Participants
Rodrigo Canellas, MD, Boston, MA (*Presenter*) Nothing to Disclose
Aoife Kilcoyne, MBBCh, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Dushyant V. Sahani, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company; Medical Advisory Board, Allena Pharmaceuticals, Inc

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PURPOSE

To evaluate the diagnostic performance of an abbreviated gadoxetic acid-enhanced MRI protocol in colorectal cancer (CRC) liver metastases surveillance.

METHOD AND MATERIALS

In this IRB approved retrospective study, gadoxetic acid-enhanced (Eovist, Bayer healthcare) MRI scans of 43 patients with histologically proven liver metastases from colorectal cancer (mCRC) were assessed. Two readers independently assessed two sets of images of each patient. The first set consisted of T2WI + 15-20 min delayed T1-WFS followed by DWI (b values ranging from 50 to 800 s/mm2) and ADC maps. Readers evaluated liver lesions and characterized them as being or malignant. A maximum number of 10 lesions per patient were recorded. Malignant classification was based on low signal on the 15-20 min T1-FS, high signal on the DWI and low signal on ADC. Benign diagnosis was based on T2 bright, hypo-intense 15-20 min T1-FS and no restricted diffusion. The full MRI protocol (set 1 + set 2 + dynamic study + other sequences) was used as our reference standard. Cohen kappa analysis was used to assess the agreement between the readers.

RESULTS

Reader 1 characterized 184 lesions as malignant and reader 2 characterized 200 lesions as malignant with a good inter-reader agreement. Although useful in lesion characterization, DWI did not add much in terms of lesion detection compared to hepatobiliary phase T1-WFS. Full MRI exam with dynamic study was found useful in characterizing previously treated 3 small metastatic lesions, but did not improve the detection of metastatic liver lesions nor the characterization of few small lesions deemed indeterminate by the abbreviated protocol. The mean time for an abbreviated protocol takes around 15 minutes to be completed compared to 35 minutes of the the full MRI protocol.

CONCLUSION

An abbreviated gadoxetic acid-enhanced MRI protocol (T2WI, DWI and 15-20 min delayed T1FS) is faster, has robust quality and provides high diagnostic performance in detection and characterization of liver lesions in mCRC surveillance.

CLINICAL RELEVANCE/APPLICATION

MRI is a scarce resource and has high demand due to the clinical benefits in variety of clinical settings. Workflow strategies need to be engineered to meet the clinical demands without compromising the diagnostic performance of MRI. An abbreviated liver MRI protocol can serve as potentially faster and lower-cost alternative to conventional MRI protocol.

SST04-07 Multiparametric Imaging Correlations with Pathology in a HCC Rat Model

Friday, Dec. 1 11:30AM - 11:40AM Room: E353B

Participants
David Fuentes, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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Rony Avritscher, MD, Houston, TX (*Presenter*) Nothing to Disclose

PURPOSE

To correlate multiparametric MR imaging with histopathological features of tumor response using a computer-implemented predictive model. This work quantifies MR imaging and pathology correlations in a hepatocellular carcinoma (HCC) rat model treated with sorafenib. Correlations of characteristic tissue hypoxia and nuclear crowding pathology features with MRI enable a non-invasive 'virtual biopsy' for understanding HCC response to sorafenib.

METHOD AND MATERIALS

Rat HCC McA-RH7777 cells were orthotopically implanted in the liver of 22 male Bufallo rats, and after 2 weeks, the animals were assigned to receive 7.5 mg/kg of sorafenib daily for 2 weeks (n=12) or to remain untreated (n=10). MR Imaging at 4.7 T was performed weekly, including anatomic, dynamic contrast-enhanced (DCE) and blood oxygenation level-dependent (BOLD) sequences. Pathology was co-registered with imaging using anatomical landmarks. Pimonidazole (PIMO) and Haemotoxylin and Eosin (H&E) staining were segmented using Gaussian mixture model to identify hypoxia, viable, and necrotic tissue. Tumor heterogeneity on pathology was quantified using the entropy of the hypoxic, viable, and necrotic tissue. The Maurer distance of each tissue type was compute to characterize the necrotic core and hypoxia relative to the HCC tumor boundary.

RESULTS

Lower entropy of the necrotic tissue was observed in the control group ($p<.05$) than the treatment group. For the PIMO stains, the distance of the hypoxic tissue in the treatment group was closer ($p=.1$) to the tumor boundary than the control group. Entropy in the pathology staining was also strongly correlated with T2star imaging ($r=.29$) but weakly correlated with BOLD effect.

CONCLUSION

Initial results demonstrate the feasibility of establishing quantitative correlations of imaging and pathology in this HCC rat model. Significant differences in entropy between groups can be used to evaluate treatment effect. Our analytical modeling platform has the potential to help predict response to sorafenib.

CLINICAL RELEVANCE/APPLICATION

Sorafenib is the only approved systemic therapy for advanced hepatocellular carcinoma. Disease control rate is achieved in less than 50% of advanced HCC patients, while nearly 10% experience grade 3-4. Therefore, imaging biomarkers are needed to identify

patients most likely to respond to sorafenib therapy.

SST04-08 Magnetic Resonance Imaging Biomarkers in Hepato-cellular Carcinoma: Correlation to Outcomes in Liver Transplant Candidates

Friday, Dec. 1 11:40AM - 11:50AM Room: E353B

Participants
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PURPOSE

To determine hepatocellular carcinoma (HCC) magnetic resonance imaging (MRI) biomarkers that enable prediction of delisting from tumor progression versus successful orthotopic liver transplantation (OLT).

METHOD AND MATERIALS

With IRB approval and HIPPA compliance, from a database of 1108 OLT listed patients with HCC from 2006-2015, patients who were delisted due to tumor progression and who had MRI at HCC diagnosis were identified. A comparison cohort of patients who went on to successful OLT without tumor recurrence matched for tumor stage and bridging therapies were then identified. Patient characteristics and MRI features upon consensus read by 3 abdominal radiologists were compared between the groups by bivariable and multivariable analsyis. The significant features were used to generate a prediction model based on MRI. Statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

There were 53 patients included in each cohort (delist-ed vs OLT with no recurrence). Significant ($p< 0.05$) MR features associated with tumor progression resulting in delisting were: T2 hyper-intensity (odds ratio [OR]= 16; 95% confidence interval [CI]: 2.49, 670.95), internal rim enhancement (OR=23.32; 95% CI: 3.42, inf), infiltrative margins (OR= 22.45; 95% CI: 4.37, 115.22), corona enhancement (OR= 4.0; 95% CI: 1.13, 14.18), and bileduct dilatation (OR= 8.17, CI: 1.54, inf). A significant favorable MR features associated with successful OLT was intralesional fat, (OR=0.36, 95% CI: 0.13, 0.99). A prediction model derived from theses variables showed an area under the receiver operating characteristic curve (AUC) of 0.86 in the prediction of delisting versus successful transplantation.

CONCLUSION

MRI findings are significantly associated with risk of tumor progression in patients awaiting liver transplantation.

CLINICAL RELEVANCE/APPLICATION

MRI features of HCC has the potential to be included in an integrated liver transplantation selection model as biomarkers of tumor biology.

SST04-09 CT Attenuation of Liver Metastases before Chemotherapy is a Predictor of Overall Survival in Colorectal Cancer: Results from the Randomized, Open-Label FIRE-3/AIO KRK0306 Trial

Friday, Dec. 1 11:50AM - 12:00PM Room: E353B

Participants
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PURPOSE

To investigate the prognostic value of pretherapeutic computed tomography (CT) attenuation values of liver metastases for overall survival (OS) in metastatic colorectal cancer (mCRC).

METHOD AND MATERIALS

In the open-label, randomized, prospective phase III FIRE-3 trial, 592 patients with histologically confirmed mCRC received 5-fluorouracil, leucovorin, and irinotecan (FOLFIRI) with either EGFR-antibody cetuximab or VEGF-antibody bevacizumab. Mean baseline attenuation [Hounsfield units (HU)] of up to five liver metastases was retrospectively measured in contrast-enhanced CT

scans of the abdomen (n=338, portal venous phase, slice thickness <=5 mm) using semi-automated volumetry. We analyzed the prognostic value of baseline HU values on overall survival (OS) using Kaplan-Meier estimate, log-rank statistics, and Cox proportional hazard regression. In addition, Receiver Operating Characteristic (ROC) analysis was employed to determine the optimal cutoff for baseline HU as predictor of prolonged OS.

RESULTS

Median baseline CT attenuation of liver metastases was 59.49 HU (IQR 49.08-68.73). In ROC analysis, baseline attenuation >61.66 HU was determined as optimal cutoff for increased OS (649 (95%-CI 587-730) days vs. 931 (777-1128), $p < 0.01$). This result was confirmed in univariate parametric Cox-regression (per 1 HU: HR=0.984, 95%-CI 0.975-0.993, $p < 0.01$). Results were consistent for subgroups based on quartiles with higher HU values being consistently associated with longer OS (median OS Q1 588 (95%-CI 460-806) days vs. Q2 663 (578-853) vs. Q3 800 (663-1096) vs. Q4 990 (777-1198)).

CONCLUSION

Increased baseline CT attenuation values >62 HU are a predictor of prolonged OS in mCRC. Measurements of CT attenuation are fast- and easy-to-perform in clinical routine and may serve as valuable prognostic imaging biomarkers in mCRC patients. Higher CT attenuation values may be the radiological representation of better vascularization of lesions. As a result, these lesions may be better to reach by and therefore more susceptible to systemic treatments.

CLINICAL RELEVANCE/APPLICATION

Liver lesions are the most common metastatic site in colorectal cancer. This work provides insights on the predictive value of the routinely assessed baseline attenuation of liver lesions on overall survival in patients from a large phase III trial.

SST05

Genitourinary (CT and MRI of Urothelium)

Friday, Dec. 1 10:30AM - 12:00PM Room: E351

CT GU MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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David D. Childs, MD, Clemmons, NC (*Moderator*) Nothing to Disclose

Sub-Events

SST05-01 Upper Tract Urothelial Carcinoma: Characterization of Lesions Missing with Ureterorenoscopy despite Previous Detection and Localization with CT Urography

Friday, Dec. 1 10:30AM - 10:40AM Room: E351

Participants
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PURPOSE

To retrospectively determine nondiminutive upper tract urothelial carcinomas (UTUCs) prospectively detected by using CT urography (CTU) but not confirmed with subsequent nonblinded ureterorenoscopy (URS).

METHOD AND MATERIALS

The institutional review board approved our study. Between 2003 and 2016, 8250 consecutive patients (mean age, 58 years±10.3) underwent 9133 CTU, which yielded 450 unique nondiminutive suspected UTUC lesions. Of 425 lesions that underwent subsequent nonblinded URS with knowledge of CTU findings-including size, location and morphology, 75 (17.7%) discordant lesions were not found at the initial unblended URS. After discordant lesions review, 30 lesions were classified as likely CTU false-positive findings without the necessity of further follow-up, and 45 lesions were classified as possible URS false-negative (FN) findings.

RESULTS

Nineteen of 75 (25.3%) of all discordant lesions after initial nonblinded URS were confirmed to be actual URS FN results, including 57.5% (19 of 33) of lesions with URS and/or CTU follow-up assessment. The average size of lesions with URS FN results was 7.5mm±3.2 and were identified with higher confidence at the prospective CTU by using the three-point scale (2.7±0.4 vs. 2.0±0.3, P=0.002). URS FN lesions were significantly more likely than concordant lesions in the calyceopelvis (73.6%, 14 of 19 vs. 41.4 %, 145 of 350; P=0.015). Eight lesions missed by using URS but confirmed by subsequent URS with surgical resection revealed adherent blood clot in one lesion and benign disease in seven lesions, and five lesions (62.5%) located in the calyceopelvis.

CONCLUSION

A priori knowledge of CTU for lesions missed at URS is more likely to have higher diagnostic confidence of the initial CTU.

CLINICAL RELEVANCE/APPLICATION

A priori knowledge of CTU for lesions missed at URS is more likely to have higher diagnostic confidence of the initial CTU.

SST05-02 Does Split-Bolus Injection Truly Influence the Ability of Renal and Urinary Lesion Detection at CT Urography? Multi-Center Prospective Randomized Comparison between Split-Bolus and Single-Bolus Injection Techniques

Friday, Dec. 1 10:40AM - 10:50AM Room: E351

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PURPOSE

To determine if split-bolus injection influences the ability of CT urography (CTU) for diagnosing the lesions in the kidney and the urinary tract.

METHOD AND MATERIALS

Institutional review board approved this multicenter prospective study. 299 patients from 11 institutions (male: female = 211: 88) had been randomly assigned to undergo CTU with split-bolus (n=148) or single-bolus (n=151) injection of CM. The degree of the renal enhancement was assessed with 3-point scale, and presence of renal cystic or solid lesion were evaluated. The urinary tract was divided into four regions (renal pelvis, upper, middle, and lower ureter), and the degree of opacification, as well as the suspicion of lesions were evaluated for each region. CT values of the renal parenchyma, renal lesions, and the renal pelvis were measured in each phase [nephrographic (NP) and excretory (EP) for single-bolus; mixed (MP) for split-bolus] and contrast ratio (CR) were calculated.

RESULTS

Although there were no differences in CTDIvol between single- and split-bolus injection, total DLP of split-bolus was significantly lower than those of single-bolus (1,425±60 vs. 2,013±59 mGycm; p<.0001). There was no difference in the degree of the urinary tract opacification between single- and split-bolus (p>.05). The renal parenchymal enhancement in NP of single-bolus achieved significantly better qualitative score than those in MP of split-bolus (p<.05), and significantly greater CT values than MP of split-bolus (162±31 vs. 128±22 HU; p<.0001). Nevertheless, there was no statistically significant difference in CR of renal lesion between in NP of single-bolus and MP of split-bolus (0.72±0.21 vs. 0.68±0.26; p>.05). CT values of the renal pelvis were significantly higher in EP of single-dose than MP of split bolus (730±505 vs. 560±421HU; p=.0009). The AUC, Sens, Spec, and Accu of urinary tract lesions were; 0.99, 100%, 94.6%, 94.7% for split-bolus, 0.99, 100%, 95.8%, 95.8% for single-bolus without NP, 0.97, 92.3%, 94.7%, 94.7% for single-bolus including NP.

CONCLUSION

CTU with split-bolus injection technique can accurately depict the lesions in the renal parenchyma and the urinary tract as single-bolus injection with reduced radiation dose.

CLINICAL RELEVANCE/APPLICATION

Split-bolus technique should be applied for the CTU considering radiation dose.

SST05-03 Analysis of Treatment Response of Bladder Cancer on CT Scans: Improved Assessment by Synergistic Combination of Radiomic Features and Clinically Estimated Feature

Friday, Dec. 1 10:50AM - 11:00AM Room: E351

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PURPOSE

To evaluate the accuracy of automatically extracted radiomic features from CT scans and clinically estimated feature in treatment response assessment of bladder cancer.

METHOD AND MATERIALS

Our Auto-Initialized Cascaded Level Set (AI-CALS) system is designed to extract 3D lesion boundary based on level sets. 47 radiomic features (RF) based on pre- and post- treatment changes in volume (V), 5 gray level (GL) and 9 shape (S) descriptors and 32 texture features (RLS) were extracted from the segmented lesions. A clinically estimated feature, the bimanual exam under anesthesia (EUA), was also collected from the clinical reports. Linear discriminant analysis was used to generate two combined response indices: one by the RFs alone (CRI-RF), and the other with both RFs and EUA (CRI-RF-EUA). With IRB approval, pre- and post-chemotherapy treatment CT scans of 98 patients with bladder cancers were collected. For all cases, cystectomy was performed after treatment and the disease outcome was available as reference standard of treatment response. 25% of patients had pT0 disease (complete response) at cystectomy. A radiologist marked 122 temporal pairs of primary site cancers. Stepwise feature selection and leave-one-case out cross-validation and receiver operating characteristic (ROC) analysis were performed. The area under the ROC curve (AUC) was calculated to estimate the accuracy for predicting pT0 stage (complete response) at cystectomy by V, CRI-RF and CRI-RF-EUA methods. Two radiologists also provided the likelihood of pT0 stage of the tumor by reading the pre- and post-treatment paired CT scans.

RESULTS

For the 122 cancers, the AUC for prediction of pT0 disease at cystectomy was 0.70±0.05 for V. The AUC for CRI-RF based on 2 Contrast and 2 RLS features was 0.74±0.05 and increased to 0.78±0.05 when EUA was added (CRI-RF-EUA). Prediction of pT0 disease by radiologists resulted in AUCs of 0.77±0.05 and 0.75±0.05, respectively. The differences did not reach significance (p>0.05).

CONCLUSION

Both CRI-RF and CRI-RF-EUA performed similar to the radiologists and better than V for estimation of treatment response. The addition of EUA further improved the accuracy of treatment response assessment.

CLINICAL RELEVANCE/APPLICATION

The combined response index using both the radiomic features and clinically estimated EUA has the potential to provide accurate treatment response assessment and is superior to volume change alone.

SST05-04 Quantification of Microvascular Changes to Predict ypT1N0 in Chemotherapeutic Response in Bladder Cancer

Friday, Dec. 1 11:00AM - 11:10AM Room: E351

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PURPOSE

To apply a parametric MRI methodology to quantify the microvascular changes in bladder tumors at the mid-treatment point of neoadjuvant chemotherapy (NAC) to predict the response with ypT1N0 endpoint.

METHOD AND MATERIALS

Thirty-eight muscle-invasive bladder cancer patients were included. Each patient had a pre-chemotherapy, a mid-chemotherapy (after 2 cycles), and a post-chemotherapy MRI, followed by radical cystectomy. The pathological findings of cystectomy specimens were used as reference standard. A patient with <=ypT1N0 was defined as a responder. MRI was performed with T2W-MRI prior to DCE-MRI on a 3T multi-transmit system (Ingenia CX, Philips Healthcare). Two pharmacokinetic parameters (Amp - signal enhancement amplitude, and kep - the exchange rate between the interstitial space and the plasma space) were estimated. For each patient, the k-means clustering of a voxel-wise Amp and kep data matrix was performed to segment their bladder tumor in 3 clusters. The volume fraction (VF) changes of 3 clusters from pre- to mid-chemotherapy MRIs were calculated and correlated with NAC response. P<0.017 was considered statistically significant for tri-parametric analysis. ROC curve analysis was performed when significant difference was found.

RESULTS

Based on pathological findings, nineteen patients with <=ypT1N0 were classified as responders, and the other nineteen patients as non-responders. The k-means clustering segmented a tumor in 3 clusters: Cluster 1 contained voxels with both low Amp and kep; Cluster 2 had voxels with high Amp and low kep; Cluster 3 had voxels with low Amp and high kep. The correlation with chemotherapeutic response showed that responders had significantly higher VF change of cluster 2 (P<0.001) and lower VF change of cluster 1 (P<0.005). There was no correlation found in the VF change of cluster 3. The ROC curve analysis calculated that AUC values were 0.81 for cluster 1 VF change and 0.78 for cluster 2 VF change.

CONCLUSION

The quantitative MRI methodology can quantify the complex microvascular changes in bladder tumor at the mid-treatment point to characterize the tumor response. The quantitative assessment can provide valuable information to predict pT1N0 endpoint before the end of NAC.

CLINICAL RELEVANCE/APPLICATION

Accurate prediction of NAC response can make substantial impact on treatment stratification to improve the outcomes of bladder cancer patients.

SST05-05 Bladder Cancer Staging in CT Urography Using Radiomic Biomarkers

Friday, Dec. 1 11:10AM - 11:20AM Room: E351

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PURPOSE

To evaluate the accuracy of a decision support system for staging of bladder cancers based on automatically extracted radiomic biomarkers from CT urography (CTU) merged in a predictive model by machine learning techniques.

METHOD AND MATERIALS

Bladder cancers at stage T2 or above are recommended for neoadjuvant chemotherapy treatment clinically. Correct staging is crucial for the decision of neoadjuvant chemotherapy and minimizing the risk of under- or over-treatment. Pre-treatment CTUs of 84 patients with bladder cancers were retrospectively collected with IRB approval. 43 cancers were below stage T2 and 41 cancers were at stage T2 or above. Our Auto-Initialized Cascaded Level Set (AI-CALS) system was used to extract 3D lesion boundary from all lesions. 87 radiomic biomarkers including 55 tumor heterogeneity and 32 morphological features (volume (V), 23 gray level (GL) and 8 shape (S)) were extracted from the segmented lesions. Linear discriminant classifier (LDA), support vector machine (SVM), and backpropagation neural network (NN), with stepwise feature selection based on F-statistics, as well as a random forest (RAF) classifier were used to combine the biomarkers into 4 predictive models for comparison. The dataset was partitioned into independent Set 1 and Set 2 for two-fold cross validation. The predictive models including feature selection were trained on one partition set and tested on the other partition set and vice versa. The area under the receiver operating characteristic curve (AUC) was calculated for each model to estimate its performance in predicting cancer stage (>= T2 or < T2).

RESULTS

The test AUC on Set 1 was 0.89, 0.92, 0.91, and 0.86 for LDA, SVM, NN and RAF, respectively. The test AUC on Set 2 was 0.90, 0.89, 0.95, and 0.96 for LDA, SVM, NN and RAF, respectively. The differences between the models did not reach statistical significance. The useful biomarkers included 2 heterogeneity features, 2 gray level features, and a contrast feature.

CONCLUSION

The machine learning techniques are promising in selecting effective radiomic biomarkers and merging them into predictive models that may provide useful decision support for bladder cancer stage assessment.

CLINICAL RELEVANCE/APPLICATION

An objective decision support system that merges computer-extracted radiomic biomarkers in a predictive model may assist clinicians in making more accurate and consistent cancer staging assessment.

SST05-06 Prospective Study of DWI and Intravoxel Incoherent Motion (IVIM) MRI as Biomarkers to Predict Clinical Aggressiveness in Bladder Cancer

Friday, Dec. 1 11:20AM - 11:30AM Room: E351

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PURPOSE

To evaluate the utility of the DWI and IVIM-MRI derived parameters in prediction of aggressiveness in bladder cancer.

METHOD AND MATERIALS

Fifty-eight patients (49 men, 9 women, mean age 61 years) were inspected through DWI and IVIM MR examination from April 2016 to March 2017. Bladder cancer (BC) was categorized in three different aggressiveness levels according to the classification criterion proposed by Kobayshi et al. The aggressiveness was classified as low- (including stage Ta and histological low-grade T1), intermediate- (high-grade T1) or high-aggressiveness (stage T2 or greater). Spearman Correlation Analysis was adopted to assess the correlation between aggressiveness and all parameters (apparent diffusion coefficient ADC, true diffusion coefficient D, pseudodiffusion coefficient D*, and perfusion fraction f). Comparisons of ADC value and IVIM parameters in different aggressiveness levels were performed using One-way analysis of variance (ANOVA). Diagnostic performance was calculated by means of receiver operating characteristics (ROC) analysis.

RESULTS

Aggressiveness of bladder cancer was negatively correlated with ADC value(r=-5.99, P < 0.001), D value(r=-5.07, P < 0.001) and f value(r=-3.64, P < 0.05). ADC, D, and f values in high-aggressive BC were significantly lower than both those in low-aggressive BC(P < 0.05) and those in intermediate-aggressive BC(P<0.05). There was not any significant difference between values of low- and intermediate-aggressive BC. The ROC analysis provided an AUC for ADC value to differentiate high-aggressive BC from low- and intermediate-aggressive BC(AUC=0.858, cut-off value =1.38mm2/s) with a sensitivity of 63.16%, a specificity of 100% and an accuracy of 75.87%, an AUC for D value(AUC=0.818, cut-off value =0.877mm2/s) with a sensitivity of 65.79%, a specificity of 95% and an accuracy of 75.86%, and an AUC for f value(AUC=0.782, cut-off value =0.33) with a sensitivity of 84.21%, a specificity of 70% and an accuracy of 79.3%.

CONCLUSION

ADC value and IVIM-derived parameters are promising biomarkers to predict aggressiveness in BC.

CLINICAL RELEVANCE/APPLICATION

(dealing with ADC value and aggressiveness)"The ADC value in DW-MRI can serve as a biomarker to predict the clinical aggressiveness of bladder cancer."

SST05-07 Comparison between Conventional Cystourethrography and MRI with Voiding MR-Cystourethrography in the Evaluation of Male Urethral Strictures

Friday, Dec. 1 11:30AM - 11:40AM Room: E351

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PURPOSE

To evaluate the accuracy of conventional retrograde and voiding cystourethrography and MRI together with voiding MR-cystourethrography in the evaluation of male urethral strictures.

METHOD AND MATERIALS

We evaluated 39 male patients with urethral strictures diagnosed with urine flow velocity recording and conventional retrograde and voiding cystourethrography. All these patients underwent MRI and voiding MR-cystourethrography using a 1.5T superconductive magnet. The patients had urine-filled bladders and high-resolution sagittal TSE T2-weighted scans were performed (TR:6250ms; TE:90ms;sl.thick.:3mm; acq.time:3'38"). Voiding MR-cystourethrography was performed with T1-weighted spoiled 3D gradient-echo acquisitions on sagittal plane (TR:12ms; TE:2,7ms; flip-angle:40°; sl.thickness: 2mm; acq.time:12s) after the filling of bladder lumen with contrast-material-enhanced urine obtainded by the i.v administration 20 mg of furosemide followed by ¾ of the normal dose of a paramagnetic contrast agent (Magnevist, Bayer Pharma, Germany). After micturition high-resolution coronal TSE T2-weighted scans were performed at the level of the stenosis. Two radiologists in consensus evaluated the morphology and length of the urethral stenosis with the two modalities and with MRI the entity and the site of spongio-fibrosis was assessed.

RESULTS

6 patients were not able to perform voiding MR-cystourethrography. In 33 patients evaluated with two imaging modalities 42 urethral strictures were detected. The measurement of the stenosis length was equal or superior with voiding MR cystourethrography and the analysis of 3D sagittal scans allowed a better evaluation of the morphology of the urethral strictures in comparison with conventional cystourethrography. 32 strictures with Spongio-fibrosis were found (76%). The site of spongio-fibrosis was always assessed with MRI (dorsal, ventral, dorsal and ventral and circular fibrosis).

CONCLUSION

MRI with voiding MR-cystourethrography shows the morphology and the length of the urethral strictures better than conventional cystourethrography and allows the detection and site of spongio-fibrosis, avoiding radiation exposure to the gonads and urinary catheterization.

CLINICAL RELEVANCE/APPLICATION

MRI could be proposed as all-in-one technique for the evaluation of urethral stenosis, allowing their detection and length assessment and determining the presence and site of spongiofibrosis.

SST05-08 Diagnostic Accuracy of MRI for T-Staging of Urothelial Bladder Cancer: Systematic Review and Meta-Analysis

Friday, Dec. 1 11:40AM - 11:50AM Room: E351

Awards
Student Travel Stipend Award

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PURPOSE

To determine the diagnostic accuracy of MRI for T-staging (≥T2) of urothelial bladder cancer (UBCa). Multi-disciplinary panel determined *a priori* that a sensitivity of >95% was necessary to obviate the need for re-resection of tumor after initial TURBT identifying

METHOD AND MATERIALS

Search of multiple databases was performed on Jan 26, 2017. Inclusion criteria: humans with UBCa who underwent pelvic MRI (>1.5T) for local staging; reference standard (surgical pathology); no chemo- or radiotherapy prior to imaging. Inclusion and data extraction was performed independently. Risk of bias was assessed using QUADAS-2. Summary estimates for diagnostic accuracy

were generated using bivariate random effects model and subgroup analyses evaluated for sources of heterogeneity.

RESULTS

13 studies (979 patients) were included. Pooled sensitivity and specificity for: A) 7 studies using only T2-W MRI = 89% (95%CI 78-95) and 55% (95%CI 45-65) and B) 8 studies using DWI = 78% (95%CI 69-85) and 78% (95%CI 70-84). Area under ROC curve (AUC) for T2WI was 0.71 and for DWI was 0.84. Summary ROC curve (SROC) is depicted in Figure 1; 95% prediction regions for T2WI and DWI do not overlap. Moderate risk of bias was identified in patient selection (3/13 studies), index test (4/13) and, reference standard (12/13); all primarily from lack of clear reporting.

CONCLUSION

MRI for T staging of UBCa demonstrates higher specificity and overall accuracy for DWI compared to only T2W-MRI. Caution is warranted; most comparisons were indirect and the majority of studies had moderate risk of bias in at least one domain.

CLINICAL RELEVANCE/APPLICATION

T-staging accuracy of UBCa (>T2) with MRI demonstrates variability with higher accuracy identified using DWI compared to T2W-MRI alone. Neither DWI nor T2W-MRI met our pre-specified criteria of >95% sensitivity suggesting that MRI is not an appropriate replacement test for re-resection of tumor following initial TURBT identifying

SST05-09 Bladder Cancer: MRI as an Alternative to Repeat Transurethral Resection of Bladder Tumor for Local Staging

Friday, Dec. 1 11:50AM - 12:00PM Room: E351

Awards
Student Travel Stipend Award

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PURPOSE

Transurethral resection of bladder tumor (TURBT) frequently understages muscle invasive bladder cancer and needs to be repeated. The purpose of this study was to determine test characteristics of multiparametric MRI (mpMRI) for the local staging of bladder cancer following TURBT, using cystectomy as the reference standard.

METHOD AND MATERIALS

This retrospective study was institutional review board approved and is HIPAA compliant. Between August 2011 and October 2016, 45 consecutive patients (median age 73 years) met inclusion criteria, which included a TURBT procedure followed by mpMRI then cystectomy without intervening neoadjuvant or intra-vesical therapies. Median time between TURBT and MRI was 43 days (SD 130, range 17-627 days). Two fellowship-trained abdominal radiologists, blinded to cystectomy staging, reviewed each mpMRI independently to document tumor T stage and regional nodal disease using all available sequences and each sequence in isolation. Sensitivity and specificity for the presence of muscle invasion (>=T2) and peri-vesical invasion (>=T3) were calculated on a stage-by-stage basis. Sensitivity and specificity for presence of regional nodal disease was assessed. Inter-observer agreement was measured using Cohen's Kappa coefficient.

RESULTS

Sensitivity/specificity for presence of muscle invasion was 92%/74% for reader 1 and 88%/84% for reader 2. Sensitivity/specificity for presence of peri-vesical invasion was 72%/92% for reader 1 and 67%/92% for reader 2. Sensitivity/specificity for regional nodal disease was 45%/93% for reader 1 and 45%/90% for reader 2. T2-WI was the most sensitive sequence for both readers for determining the presence of muscle invasion and peri-vesical invasion, while DWI was the most sensitive for regional nodal disease. The most specific sequence varied between readers. Inter-observer agreement was substantial for presence of muscle invasion, peri-vesical invasion and regional nodal disease when all sequences were used.

CONCLUSION

mpMRI is sensitive and specific at determining bladder cancer muscle and peri-vesical invasion in patients who have undergone prior TURBT. mpMRI was specific but not sensitive for assessing regional nodal disease.

CLINICAL RELEVANCE/APPLICATION

Multiparametric MRI is sensitive and specific at bladder cancer local staging following TURBT. Current bladder cancer management guidelines could consider mpMRI as an alternative to repeat TURBT.

SST06

Science Session with Keynote: Musculoskeletal (Spine)

Friday, Dec. 1 10:30AM - 12:00PM Room: E451A

CT MK MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
William E. Palmer, MD, Boston, MA (*Moderator*) Nothing to Disclose
Marcelo Bordalo-Rodrigues, MD,PhD, Sao Paulo, Brazil (*Moderator*) Nothing to Disclose

Sub-Events

SST06-01 Musculoskeletal Keynote Speaker: Update in Spine Imaging

Friday, Dec. 1 10:30AM - 10:40AM Room: E451A

Participants
William E. Palmer, MD, Boston, MA (*Presenter*) Nothing to Disclose

SST06-02 CT-Based Structural Analysis Predicts Failure of Human Spines with Simulated Osteolytic Defects under Functional Loads

Friday, Dec. 1 10:40AM - 10:50AM Room: E451A

Participants
Ron N. Alkalay, PhD, Boston, MA (*Presenter*) Nothing to Disclose
Robert Adamson, MSc, Bosotn, MA (*Abstract Co-Author*) Nothing to Disclose
David B. Hackney, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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N/A

PURPOSE

To compare the accuracy of a) CT based structural analysis protocol (CT-SAP) b) bone mineral density (BMD) and c) lesion size in predicting vertebral strength in a lytic lesion model of human vertebral metastatic disease.

METHOD AND MATERIALS

We created lytic defects in the middle vertebra of 40 cadaver thoracic and lumbar 3-level spinal segments from donors aged 48-57 years (Fig 1). The segments were imaged using a clinical CT spine protocol (field of view = 16cm, voxel dimensions: (0.31*0.31*0.625)mm . The segments were then tested to failure in either compression or in compression + torsion (3Nm). Linear regression models (JMP 9, SAS, NC) tested the correlations of a) defect size, b) BMD and c) CT-SAP predicted failure load with measured vertebral strength.

RESULTS

- Compression loading: Within an intentionally small range of defect diameters, lesion size was not correlated with vertebral strength (Fig 2.C). CT-SAP showed significantly higher prediction accuracy for vertebral strength than did BMD (Fig 2.B), (ANCOVA, $p<0.01$), Fig 2.A. - Compression + torsion loading: Lumbar vertebrae showed 12% reduction in mean strength than in pure compression Thoracic spines showed 34% higher strength than in compression alone ($p<0.05$). CT-SAP again had significantly higher prediction accuracy than BMD (Fig 2.C), $p<0.05$, but both measures showed lower prediction accuracy compared to the compression-only tests.

CONCLUSION

CT-SAP is superior to lesion size and BMD in predicting the strength of human vertebrae with lytic defects. These results are achieved by modeling the material properties and spatial distribution of the bone throughout the vertebral volume. Incorporation of a more realistic loading regime (compression + torsion) brings this in vitro model closer to actual stresses applied in vivo. The novel finding of regional differences in the effect of torsional loading on vertebral strength highlights the need to incorporate local variation in facet geometry in intervertebral kinematics, effecting local load transfer, in order to improve CT-SAP prediction accuracy.

CLINICAL RELEVANCE/APPLICATION

There are no objective and precise methods for predicting fracture risk in patients with spinal metastases. Subjective protocols such as SINS have limited accuracy. CT-SAP appears to provide more reliable objective predictions.

SST06-03 The Differential Diagnosis of Benign and Malignant Vertebral Compression Fracture with MR Fat-Water Separation Dixon Technique at 3.0T: A Retrospective Study

Friday, Dec. 1 10:50AM - 11:00AM Room: E451A

Participants
Hui Tan, Xianyang, China (*Presenter*) Nothing to Disclose
Qiuju Fan, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose
Nan Yu, MD, Xian Yang, China (*Abstract Co-Author*) Nothing to Disclose
Qi Yang, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The purpose of our study was to explore the value of fat-water separation Dixon technique in differential diagnosis of benign and malignant vertebral compression fractures.

METHOD AND MATERIALS

We retrospectively analyzed 76 patients with vertebral lesions who scanned at a CT scanner, and can not confirm the diagnosis. Then all patients underwent fat-water separation Dixon T1WI sequence on a MAGNETOM Skyra 3.0T MR scanner (Siemens AG, Erlangen, Germany). The patients were identified as either benign compression fractures (35 osteoporotic fractures,5 traumatic fractures, 3 infective fractures;age,28-76 years) or malignant compression fractures (28 metastatic fractures,3 multiple myeloma, 2 non-Hodgkin lymphoma; age,34-81 years) based on clinical follow-up or pathologically results. Besides general protocols for vertebral disease, the water-fat separation Dixon T1-VIBE protocol was included with the following parameters, TR/TE= 600/9.5ms, slice thickness=3mm, FOV= 340mm, matrix =384x384, iPAT = 2, Number of slices=16, and Average= 1. Four series of images (in/opposed phases, fat/water only) generated by the system were used for FF analysis. The signal intensity ratio was defined as SIR= SIopp-phase/ SIin-phase and the fat fraction was defined as FF= SIfat/ SIin-phase×100%.

RESULTS

The value of FF (27.43±6.77) in the benign group was significantly higher than that in the malignant group (11.88±4.23) (P<0.01).The SIR (0.72±0.28) in the benign group was significantly lower than that in the malignant group (1.38±0.21) (P<0.01).Through drawing ROC curve used the FF and SIR of benign and malignant vertebral compression fractures, the diagnostic critical value of benign and malignant vertebral compression fractures was12.75 and 0.86. The AUC of FF and SIR were 0.75 and 0.86.

CONCLUSION

The vertebral signal intensity and fat fraction through 3.0T MR fat-water separation Dixon technique can reflect the change of the vertebral body fat content in patients, and is helpful in differentiation in between benign and malignant vertebral compression fractures.

CLINICAL RELEVANCE/APPLICATION

(dealing with MR Dixon technique) '3.0T MR fat-water separation Dixon technique can demonstrate alterations in vertebral body fat content and this exam is recommended when the underlying cause of vertebral lesion is unclear.'

SST06-04 Validation of T2 Weighted Images for Assessing Fat Infiltration in Paraspinal Muscles Using an Osirix Application

Friday, Dec. 1 11:00AM - 11:10AM Room: E451A

Participants
Cristobal Arrieta, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose
Pablo Besa, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose
Ignacio J. Osorio, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose
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Daniela Esparza, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Fat infiltration in paraspinal muscles has shown to be related to low back pain risk and it has been quantified using a manual thresholding yielding to quantification errors. Moreover, although the segmentation is typically done in T2w images, this has not been validated. We proposed a software to automatically segment FI in PM using T2w images. The software was validated against manual segmentations using Dixon images as a gold standard since they do not contain water nor B0 inhomogeneities.

METHOD AND MATERIALS

We used T2w and Dixon images from 10 healthy volunteers and 10 patients, acquired in a Philips Ingenia 3.0T scanner (TE 110ms, TR 4160ms for T2w) with an acquisition matrix of 324x324 and a pixel resolution of 0.4x0.4x4mm. To segment fat, we developed an Osirix plugin based on PyOsirix, which allows for running Phyton scripts over the Osirix database. We manually define 4 ROIs per slice for the erector spinae and multifidus muscles and from L1-L2 to L5-S1. An automatic threshold is determined for each ROI. For the gold standards, we copy the same ROIs into the Dixon images and then we found a threshold manually. For the statistical analysis, we performed two-tail paired t-test, Pearson correlation, Bland Altman analysis and linear regression.

RESULTS

Two-tail paired t-test of the segmented areas showed that there is not significant difference between gold standard and our method (P=0.61). Linear regression showed the good agreement between the two methods (Y=0.91X+0.21 cm2). Pearson correlation was 0.89 and Bland Altman plots showed a low bias (-0.016 cm2) and limits of agreement of [-1.270, 1.238] cm2. Fortin and Batiié (2012) reported 9 minutes for manually finding the threshold for fat segmentation in T2w images. Our Osirix plugin performs the segmentation in a fraction of second per ROI.

CONCLUSION

We developed an Osirix plugin to automatically quantify FI in PM using T2w images. Our plugin showed an excellent agreement and no significant difference with manual segmentation using Dixon images. Our plugin reduces the processing time from minutes to a few seconds. As future work, we are developing techniques for facilitating the PM delimitations to define the ROIs.

CLINICAL RELEVANCE/APPLICATION

We validated a software to automatically segment the fat infiltration in paraspinal muscles using T2w images. We used manual segmentation in Dixon images as a gold standard.

SST06-05 Quantitative T2 Magnetic Resonance Imaging Compared to Morphological Grading of the Early Cervical Disc Degeneration in Asymptomatic Volunteers by T2 Relaxation Mapping

Friday, Dec. 1 11:10AM - 11:20AM Room: E451A

Participants
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PURPOSE

The purpose of this study was to assess cervical disc degeneration quantitatively by using T2 Relaxation mapping.

METHOD AND MATERIALS

22 asymptomatic young subjects (11 men and 11 women; 21.73±2.01 years) were enrolled in this study. All date were collected on a 3.0 T MRI(Skyra,Siemens Healthcare, Erlangen, Germany);Therefore, the morphological date of 132 cervical disc covering C2 to T1 were obtained (Cervical sagittal T2-weighted, sagittal and axial T2 relaxation MRI) covering discs C2-C3 to C7-T1. All MR images in this study were acquired in the afternoon to minimize the diurnal variation of T2 values in the discs. All the discs were morphologically assessed according to the Miyazaki grade. Morphological evaluation of images were carried out by 2 radiologists with 10 years experience of musculoskeletal radiology in consensus. Six discs (C2-T1) of the cervical spine were put Regions of interest (ROIs) over axial T2 mappings images, including nucleus pulposus (NP),anterior and posterior annulus fibrosus (AF). To minimize the error in identifying nucleus pulposus (NP) anatomic structure, free hand ROIs were put carefully matched to the NP shape.The value of AF was calculated by the average between AAF and PAF. Mean T2 values were recorded using Siemens SyngoVIA workstation.Wilcoxon signed rank test, Kruskal-Wallis test, and Spearman rank correlation were performed. Correlations were considered as strong for r>0.7, moderate for 0.5< r<0.7, and weak for r<0.5. All statistical analysis was performed by SPSS software (v16.0, SPSS Inc., Chicago, IL, USA), P<0.05 was considered statistically significant.

RESULTS

The difference in T2 values between NP and AF were highly significant (P<0.001). The trends of decreasing T2 mapping values of both NP and AF with increasing Miyazaki grades was significant (P<0.01), particularly between Miyazaki grade I and II (P<0.001). Miyazaki grades were inversely significantly correlated with T2 values in the NP (r=-0.8901, P<0.001) and AF (r=-0.7446, P<0.001).

CONCLUSION

The process of cervical disc degeneration can be detected by T2 mapping, particularly at early stage. It displays comparable trends as Miyazaki grades does.

CLINICAL RELEVANCE/APPLICATION

Quantitative, objective and non-invasive evaluation of T2 mapping in intervertebral disc degeneration can prevent, diagnose and evaluate the clinical effect of spinal diseases.

SST06-06 Value of Psoas Proximal Insertion for Numbering Lumbar Vertebrae

Friday, Dec. 1 11:20AM - 11:30AM Room: E451A

Participants
Francois n. Ropars, Brest, France (*Presenter*) Nothing to Disclose
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Julien Ognard, MD, MSc, Brest, France (*Abstract Co-Author*) Nothing to Disclose
Solene Querellou, Brest, France (*Abstract Co-Author*) Nothing to Disclose
Jean Rousset, MD, Brest, France (*Abstract Co-Author*) Nothing to Disclose
Marc Garetier, MD, Brest, France (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the value of psoas muscle proximal insertion for correct numbering of the lumbar vertebrae in MRI, in particular in case of lumbosacral transitional vertebra (LSTV).

METHOD AND MATERIALS

Two radiologists assessed independently 477 MRI of the lumbar spine with coronal STIR sequence and a sagittal localizer sequence on the whole spine. The last lumbar vertebra was by counting caudally from C2, and its morphology was evaluated according to Castellvi classification as modal lumbosacral junction (N) or LSTV (C). The proximal insertion level of psoas muscle was assessed on coronal STIR sequence. It was named as the most proximal vertebrae with psoas over half of its body. The same parameters were assessed on 207 PET-CT of other patients including the whole spine to compare MRI and CT data with a Fisher's exact test, considering CT as gold standard for anatomical consideration, due to millimetric slices and possibility of multiplanar reconstructions.

RESULTS

Among the 477 patients, 405 patients (84,9%) had a modal last lumbar vertebra (L5N), 43 patients (9%) a LSTV (L4/5/6C+) and 29 patients (6,1%) a missing or supernumerary lumbar vertebra without LSTV (L4/6N). The psoas proximal insertion was L1 in 449 patients (94,1%), T12 in 8 patients (1,7%) and L2 in 20 patients (4,2%). It was L1 in 98,5% in case of L5N, 81,0% in case of LSTV, and 81,3% and 15,4% in case of L4N or L6N respectively. The interreader agreement for determination of psoas proximal insertion was excellent (Kappa = 0.96). There was no statistically significant difference between MRI and CT data ($p<0,05$).

CONCLUSION

Coronal STIR sequence has a high-performance for the determination of the psoas proximal insertion. Determination of psoas proximal insertion is an accurate, valuable and easy way for correctly number lumbar vertebrae. In case of a modal anatomy (L5N), it's almost always L1 (98%). Controversely, this insertion is not necessarily T12 or L2 according to the presence of missing or supernumerary lumbar vertebrae, with or without LSTV. In these situations, psoas even keeps an insertion on L1 in the majority of cases, except in L6N group.

CLINICAL RELEVANCE/APPLICATION

Radiologists should have a look on psoas proximal insertion in lumbar spine MRI. If this insertion is not 5 vertebral bodies above the lumbosacral joint, there is a high probability of variation in the number of lumbar vertebrae.

SST06-07 The Value of Golden-Angle RAdial Sparse Parallel (GRASP) Imaging for Differentiation between Infectious Degenerative Modic Type 1 Changes of the Spine

Friday, Dec. 1 11:30AM - 11:40AM Room: E451A

Participants
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Kai Tobias Block, PhD, New York, NY (*Abstract Co-Author*) Royalties, Siemens AG
Oliver Bieri, PhD, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Dorothee Harder, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Bram Stieltjes, MD,PhD, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The aim was to assess whether a T1w3D sequence with contrast for dynamic MR imaging, Golden-angle RAdial Sparse Parallel (GRASP) was able to distinguish between benign and pathologic vertebral compression fractures.

METHOD AND MATERIALS

Twelve patients with non-necrotic metastases in non-fractured VBs (mean 66 years), 11 patients with VB compression fractures without a history of a malig-nancy (mean 74 years), and 8 patients with VB compression fractures caused by osseous metastases (63 years) were examined by conventional MRI and GRASP at 1.5 or 3T (Siemens). Imaging parameters of the GRASP sequence were: TA 4:20 min, TR/TE 5.92/1.78 msec, slice thickness 2.5 mm, voxel size 1x1x2.5 mm. A region of interest (ROI) was placed in the pathologic-appearing VB and in a normal-appearing VB, whereby the latter served as a reference. The ROIs of metastatic non-fractured VBs served as a further reference.

RESULTS

The three patients groups did no show any difference in the maximum contrast-enhancement intensity, and all showed a higher contrast-enhancement than the normal-appearing VBs. In all VB fractures without malignancy the time-contrast-enhancement intensity course was almost parallel to that of the normal-appearing VB consisting of a fast increase of contrast enhancement (at 40-85 sec) shortly afterwards reaching a plateau (80-175 sec). On the other side, all metastases without fracture manifested a slightly earlier and very fast increase of contrast-enhancement (at 30-55 sec) immediately fol-lowed by a prolonged and weak decrease of enhancement towards a late plateau (>175 sec). The time-intensity contrast-enhancement curves of the pathologic fractures were quite similar to that of the metastatic non-fractured VBs (slope 35-65 sec, plateau >175 sec).

CONCLUSION

Pathologic VB fractures, however, can be distinguished from benign compression fractures by a different time intensity contrast-enhancement curve, whereby the dynamic differences can be attributed to differences in cellularity, edema, and vascularity of the bone. We conclude that GRASP imaging may be a promising sequence for the differentiation between benign and pathologic fractures, which may be of great value in patients in which the primary cause for the fracture cannot be evaluated by conventional MRI.

CLINICAL RELEVANCE/APPLICATION

GRASP imaging may be a promising tool for the differentiation between benign and pathologic fractures with MRI.

SST06-08 Texture Analysis of Paraspinal Musculature in MRI of the Lumbar Spine: Analysis of the Lumbar Spinal Outcome Study (LSOS) Data

Friday, Dec. 1 11:40AM - 11:50AM Room: E451A

Participants
Manoj Mannil, Zurich, Switzerland (*Presenter*) Nothing to Disclose
Jakob Burgstaller, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

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Michael Betz, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Ulrike Held, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Roman Guggenberger, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the clinical impact of fatty infiltration in paraspinal musculature on Spinal Stenosis Measure (SSM) Score and Walking Distance, at baseline and regarding changes after 12 months in patients suffering from lumbar spinal stenosis (LSS) using the qualitative Goutallier staging and quantitative Texture Analysis (TA) in Magnetic Resonance Imaging (MRI).

METHOD AND MATERIALS

In this retrospective, institutional review board approved study, TA was performed on axial T2 weighted MR images at level L3/4 using dedicated software (MaZda) in 62 patients with LSS. The association between Goutallier and TA findings with two clinical outcome measures, Spinal Stenosis Measure (SSM) Score and Walking Distance, at baseline and regarding changes after 12 months were assessed using machine learning algorithms (Random Forest) for TA feature reduction, followed by multiple logistic regression models.

RESULTS

Quantitative assessment of fatty infiltration using the histogram TA feature „mean" showed higher interreader reliability (ICC 0.83-0.97) compared to the Goutallier staging (κ = 0.69 to 0.93). No correlation between Goutallier staging and two clinical outcome measures at baseline and after 12 months was observed. Among 151 TA features in all paraspinal muscle groups, only TA feature "mean" of the spinotransverse group showed a significant but weak correlation with worsened SSM (p = 0.046) and TA feature "S(3,3) Entropy" as a measure of altered microarchitecture showed a significant but weak association with worsened walking distance over 12 months (p = 0.046). However, after correction for multiple testing no clear association can be observed.

CONCLUSION

MR TA is a reproducible tool to quantitatively assess paraspinal fatty infiltration, but its association with clinical outcomes in LSS patients is very limited.

CLINICAL RELEVANCE/APPLICATION

MR TA is a reproducible tool to quantitatively assess paraspinal fatty infiltration and mircoarchitectural changes, but its association with clinical outcomes in Lumbar Spinal Stenosis patients is limited.

SST06-09 Optimization of 2nd TE with Subtraction Image Using Ultra-Short TE for the Lumbar Cartilaginous Endplates in Human in Vivo

Friday, Dec. 1 11:50AM - 12:00PM Room: E451A

Participants
Mika Yanagida, Sapporo, Japan (*Presenter*) Nothing to Disclose
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PURPOSE

Dual echo acquisition with later echo subtraction has been used for suppressing long T2 signals in ultra-short TE (UTE) imaging.In this study, we evaluated the optimal 2nd TE with subtraction images using UTE for lumbar cartilaginous endplates (CEP) in human in vivo.

METHOD AND MATERIALS

The subjects were 20 patients who had low back pain and degenerative lumbar disorders (12 males, 8 females; average age: 41.3±8.7 years). All subjects were performed with a 3-tesla MR system (Ingenia, Philips Healthcare, The Netherlands) using a dS Torso coil. We used a 3D sequence (TR, 23ms; flip angle, 15°) with fat suppression that UTE was acquired with a phased-encoded stack of spirals trajectory as the first TE and four gradient echoes as the second TE following the first echo. TEs were set at 0.16, 4.6, 9.2, 13.8, and 18.2ms. Scanning was performed around lumbar spine, sagittal slice orientation, 60 slices, 0.94mm×0.94mm×4.8mm voxel size, and 17-minute scan time. Signal intensity of CEP and intervertebral discs (IVD) and vertebral bodies (VB) at the level of L3/L4 in region of interests (ROIs) were measured on the subtraction images (first TE minus second TEs). The ROIs were measured by a research scientist analyzing MR images and a spine surgeon. Furthermore, we calculated the contrast ratio (CR) of CEP/IVD and CEP/VB. To calculate the inter measurers variability, we expressed an intraclass correlation (ICC) with CR. The Friedman test was used for statistical significance, which was set at a p-value of <0.05. All statistics were performed in SPSS version 20.0 (IBM, SPSS Inc.).

RESULTS

CR for CEP/IVD was 47.9±15.5 for 4.6ms, 62.6±21.6 for 9.2ms, 65.8±20.4 for 13.8ms, and 48.5±22.0 for 18.2ms. CR of 9.2 and 13.8ms was significantly higher than that of 4.6 and 18.2ms (p<0.01). Furthermore, CR for CEP/VB was 9.3±4.1 for 4.6ms, 9.5±3.5 for 9.2ms, 18.7±4.3 for 13.8ms, and 22.3±5.8 for 18.2ms. CR of 13.8 and 18.2ms was significantly higher than that of 4.6 and 9.2ms (p<0.01). ICC of two measurers was 0.939 for CEP/IVD and 0.924 for CEP/VB.

CONCLUSION

The optimal 2nd TE with subtraction image was 13.8ms in human CEPs.

CLINICAL RELEVANCE/APPLICATION

Dual echo acquisition with UTE is useful for diagnosing degenerative changes of CEPs such as Modic changes.

RSNA 2017 Explore. Invent. Transform.
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McCormick Place, Chicago
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SST07

Nuclear Medicine (Chest Imaging)

Friday, Dec. 1 10:30AM - 12:00PM Room: E353C

CH CT MR NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Ephraim E. Parent, MD, PhD, Atlanta, GA (*Moderator*) Nothing to Disclose
Andrew C. Homb, MD, Rochester, MN (*Moderator*) Nothing to Disclose

Sub-Events

SST07-01 Whole-Body FDG-PET/MRI: Comparison of its Capability for TNM Staging with that of Whole-Body MRI, Integrated FDG-PET/CT and Conventional Radiological Examination in Patients with Malignant Pleural Mesotheliom

Friday, Dec. 1 10:30AM - 10:40AM Room: E353C

Participants
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PURPOSE

To directly and prospectively compare the TNM staging capability among whole-body co-registered FDG-PET/MRI, MRI with diffusion-weighted imaging (DWI), integrated FDG-PET/CT and conventional radiological examination in patients with malignant pleural mesothelioma.

METHOD AND MATERIALS

23 consecutive pathologically diagnosed malignant mesothelioma patients (14 men, 9 women, mean age 69.2 years old) underwent whole-body MRI including DWI, integrated PET/CTs, conventional radiological examinations, pathological examinations and surgical reports as well as follow-up examinations. TNM staging was evaluated by three different reader groups including radiologists with more than three year experiences of whole-body MRI and PET/CT and nuclear medicine physicians. Kappa statistics were determined for evaluations of agreements of each factor and the clinical stage between each of the methods and final diagnosis. Finally, the diagnostic accuracy of each factor and of determination of the clinical stage was statistically compared with each other by using McNemar's test.

RESULTS

T factor agreements were determined as substantial (PET/CT and conventional examination: kappa value=0.61) or almost perfect (PET/MRI and MRI: kappa value=0.86). N factor agreements were also determined as substantial (PET/CT: kappa value=0.73, conventional examination: kappa value=0.61) or almost perfect (PET/MRI and MRI: kappa value=1.00). M factor assessment, agreements were also determined as moderate (conventional examination: kappa value=0.47), substantial (MRI: kappa value=0.78) or almost perfect (PET/MRI and PET/CT: kappa value=1.00). In addition, clinical stage agreements were determined as substantial (PET/CT and conventional examination: kappa value=0.70) or almost perfect (PET/MRI and MRI: kappa value=0.87). Finally, accuracies of N factor evaluation on PET/MRI and MRI (100 [23/23] %) were significantly higher than that of conventional examination (73.9 [17/23] %, p=0.03).

CONCLUSION

Whole-body PET/MRI and MRI with DWI are potentially more useful for TNM stage assessment than conventional radiological examination, and can be considered at least as effective as PET/CT.

CLINICAL RELEVANCE/APPLICATION

Whole-body PET/MRI and MRI with DWI are potentially more useful for TNM stage assessment than conventional radiological

examination, and can be considered at least as effective as PET/CT.

SST07-02 Prognostic Value of Metabolic Variables of [18F]FDG PET/CT in Surgically Resected Stage I Lung Adenocarcinoma

Friday, Dec. 1 10:40AM - 10:50AM Room: E353C

Participants
Xiaoyi Wang, MD, Beijing, China (*Presenter*) Nothing to Disclose

PURPOSE

The objective of this study was to assess the prognostic value of metabolic tumor burden measured by positron emission tomography/computed tomography (PET/CT) in patients with stage I lung adenocarcinoma.

METHOD AND MATERIALS

We reviewed 127 consecutive patients with pathologically proven stage I lung adenocarcinoma who underwent pre-treatment [18F]FDG PET/CT scans in our hospital from 2005 June to 2012 June. The maximum, mean and peak standardized uptake value (SUVmax, SUVmean and SUVpeak), metabolic tumor volume (MTV), total lesion glycolysis (TLG) and computed tomography volume (CTV) were measured. The Kaplan-Meier and Cox proportional hazards model were used with age, gender, TNM stage, clinical stage, histological grade, nodule type, tumor size and metabolic parameters to predict progression-free survival (PFS). The cut-off point was determined through ROC curve.

RESULTS

In univariate analysis, the histological grade, nodule type, diameter (cut-off value of 2.0cm), CTV (6.56cm3), SUVmax (3.25g/ml), SUVmean (1.58g/ml), SUVpeak (1.84g/ml), MTV (4.80cm3) and TLG (10.40) were significantly associated with PFS (all P value <0.05). Patients with poorly differentiated adenocarcinoma, solid nodule type, large size, high metabolic tumor burden were associated with poor prognosis. In multivariate analysis, only histological grade was independent prognostic factors for progression with a P value of 0.005 (RR, 0.355; 95 % CI, 0.173-0.728). Among five PET/CT metabolic parameters, only MTV was independent prognostic factors for progression with a P value of 0.031 (RR, 1.118; 95 % CI, 1.010-1.237).

CONCLUSION

Histological grade was an independent predictor for progression in patients with stage I lung adenocarcinoma. Among five PET/CT metabolic parameters, only MTV was an independent predictor for progression.

CLINICAL RELEVANCE/APPLICATION

Owing to the high heterogeneity, there is quite a limitation in treatment planning and prognosis predicting only based upon TNM stage and pathological type. Recently, several researches have already proved that SUVmax, MTV and TLG had prognostic and predictive value in NSCLC patients. Howerer, previous studies focused primarily on advanced stage disease, few studies have reported the role of those parameters in early stage adenocarcinoma. This study was conducted to document the prognostic role of metabolic tumor burden parameters in patients with stage I lung adenocarcinoma.

SST07-03 Comparison of Different Automated Lesion Delineation Methods for Metabolic Tumor Volume of 18F-FDG PET/CT in Patients with Stage I Lung Adenocarcinoma

Friday, Dec. 1 10:50AM - 11:00AM Room: E353C

Participants
Xiaoyi Wang, MD, Beijing, China (*Presenter*) Nothing to Disclose

PURPOSE

Defining metabolic tumor volume (MTV) of small and/or low uptake lesions using positron emission tomography/ computed tomography (PET/CT) is usually challenging since the variation is generally high. The aim of this paper is to investigate the suitable segmentation method in small, low uptake and heterogeneous stage I lung adenocarcinoma.

METHOD AND MATERIALS

One-hundred and thirty-three stage I lung adenocarcinoma patients with 2-deoxy-2-[18F]fluoro-D-glucose PET/CT scans were enrolled in this retrospective study. All lesions were divided into different groups according to nodule density (16 non-solid, 30 part-solid and 87 solid), nodule size (53 small lesions with longest diameter <= 20 mm; 80 large lesions with longest diameter >20 mm) and the maximum standard uptake value (SUVmax) level (57 low uptake lesions with SUVmax <= 2; 76 high uptake lesions with SUVmax > 2). The MTVs of the four different PET segmentation methods were evaluated and compared with CT volume (CTV). Percentage volume error (%VE) compared to CTV was calculated and the correlations between MTVs and CTV were analyzed.

RESULTS

The adaptive iterative algorithm (AT-AIA) had the highest accuracy in large, high uptake and solid nodules (72.5%, 72.4% and 65.6%, respectively). The method of adaptive thresholding at 40% SUVmax (AT40%) had the highest accuracy in small, low uptake and non-solid nodules (56.6%, 56.1% and 62.6%, respectively). In part-solid nodules, the accuracy of AT-AIA (60.0%) and AT40% (56.7%) were higher than that of the other two methods. The MTV of AT-AIA was in excellent consistent with the CTV in solid nodules (R=0.831, P=0.000) and in high uptake nodules (R=0.830, P=0.000). The MTV of AT40% was in good consistent with the CTV in non-solid nodules (R=0.686, P=0.003) and in part-solid nodules (R=0.731, P=0.000).

CONCLUSION

AT40% showed best performance in small, low uptake, non-solid and part-solid lesions. AT-AIA was suitable for large, high uptake and solid lesions.

CLINICAL RELEVANCE/APPLICATION

Up to now, defining metabolic tumour volume of small and/or low uptake lesions is still challenging since the variation is generally high. The aim of this study is to investigate the suitable segmentation method in small, low uptake and heterogeneous stage I lung

adenocarcinoma.

SST07-04 Decrease in SUV Max of a Solitary Pulmonary Nodule (SPN) in Dual-Time FDG-PET/CT Imaging: Does it Reliably Exclude Malignancy?

Friday, Dec. 1 11:00AM - 11:10AM Room: E353C

Participants
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PURPOSE

FDG-PET/CT is a well established modality for evaluating indeterminate solitary pulmonary nodules (SPN). Although the sensitivity for detecting malignancy is considered quite high, the specificity is lower. By adding delayed imaging (Dual-Time PET/CT), the specificity for malignancy improves, since malignant SPN increase glucose utilization over time, i.e. an increase by > 10% in the maximum standardized uptake value (SUV Max). By contrast, a decrease or no significant change in SUV Max suggests benign etiology. We observed, however, that it was not uncommon for biopsy-proven malignant nodules to show either no significant change or a decrease in SUV Max on delayed imaging. Our aim was to (1) determine the frequency of this pattern and (2) to correlate with histopathology.

METHOD AND MATERIALS

From 2007 through 2016, we collected all cases of FDG-PET/CT scans used for SPN evaluation in which the final diagnosis was lung malignancy, yet the SUV Max either did not significantly change, or decreased by 10% or more on delayed imaging.

RESULTS

A total of 86 patients met the above criteria, 50 men and 36 women. In 40 of the patients (Group A), the SUV Max decreased by $\geq$ 10%, which was considered a significant decrease. Of these, 23 patients had adenocarcinoma, 4 had squamous cell, 4 had small cell, and 13 had bronchoalveolar (BAC). The remaining 46 patients (Group B) demonstrated either no significant change in SUV Max, or a decrease less than 10%; 15 had adenocarcinoma, 13 had small cell, 7 had BAC, and 11 had squamous cell cancer.

CONCLUSION

(1) Although a significant increase in SUV Max in dual-point FDG PET/CT imaging generally indicates SPN malignancy, a decrease or lack of change in SUV does not necessarily mean a benign etiology. (2) Adenocarcinoma is the most common cell type in which SUV Max decreases or does not significantly change, likely a reflection of tumor differentiation.

CLINICAL RELEVANCE/APPLICATION

A lack of change or a significant decrease in SUV Max over time of an SPN does not exclude malignancy and this pattern is unreliable in SPN evaluation.

SST07-05 18FDG Uptake Patterns by Mediastinal Lymph Nodes and EBUS in the Nodal Staging of Patients with Non-Pulmonary Malignancies

Friday, Dec. 1 11:10AM - 11:20AM Room: E353C

Participants
Socrates Angelides, MBBS, Westmead, Australia (*Presenter*) Nothing to Disclose
Andrew Markewycz, BMedSc, Westmead, Australia (*Abstract Co-Author*) Nothing to Disclose
Josh Escabach, BMedSc, Westmead, Australia (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To retrospectively compare 18FDG-PET scans and EBUS findings in patients with documented mediastinal lymphadenopathy and non-pulmonary primary malignancies.

METHOD AND MATERIALS

25 patients with documented mediastinal lymphadenopathy and non-pulmonary primary malignancies underwent 18FDG-PET scintigraphy followed by EBUS within the ensuing 3 weeks. One-two nodes (n = 29) were assessed in each patient, determined by 18FDG-PET findings and accessibility of the 18FDG-positive nodes. The mediastinal nodal status from each procedure was compared.

RESULTS

EBUS resulted in mediastinal nodal status downgrading in 60% patients. No upgrading was noted. Downgrading most likely occurred when there several non-enlarged lymph nodes of similar 18FDG-avidity distributed randomly and bilaterally in the mediastinum, often with bilateral hilar uptake (~80% of patients). 100% patients with positive EBUS findings for malignant disease demonstrated discrete 18FDG-avid lymph nodes ipsilaterally, with minimal-to-no 18FDG-avid nodes contralaterally. EBUS findings in 20% of patients were inconclusive, despite multiple sampling. Enlarged, rounded lymph nodes with avid FDG uptake (SUV>4) were also more likely to harbour metastatic disease.

CONCLUSION

The pattern of mediastinal 18FDG uptake was highly predictive of metastatic disease, and may circumvent the need for EBUS

evaluation. Prospective analysis of these parameters will be undertaken.

CLINICAL RELEVANCE/APPLICATION

Patterns of 18FDG uptake in mediastinal lymph nodes may circumvent the need for EBUS assessment.

SST07-06 Short TE and Low Flip Angle VIBE Sequence for Lung Evaluation in PET-MRI

Friday, Dec. 1 11:20AM - 11:30AM Room: E353C

Participants
Alessia Varotto, MD, Padova, Italy (*Presenter*) Nothing to Disclose
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PURPOSE

Low-dose CT in standard PET/CT offers a better morphological lung characterization when compared with Dixon sequences in PET/MRI. Our aim is to improve diagnostic accuracy for lung lesions detection with PET/MRI avoiding a significant increase in the acquisition time, adding a short TE (Echo Time) and low FA (Flip Angle) T1-weighted sequence (gradient-echo volumetric interpolated breath-hold examination [VIBE]) to the standard acquisition protocol.

METHOD AND MATERIALS

We enrolled 21 oncological patients (11 M and 10 F) who underwent both thoracic CT scan and 3T PET-MRI (Siemens Biograph mMR) including lung dedicated short TE and low FA VIBE (inspiration, 3 mm slice thickness, axial plane). Time interval between the two examinations was < 2 weeks. VIBE sequences were retrospectively and independently evaluated by two radiologists for the detection of pulmonary nodules, parenchymal consolidations and dense bands; to assess inter-observer agreement Cohen's kappa coefficient (κ) was calculated. Results were then compared with CT scans findings, considered as the gold standard. Sensitivity and specificity were calculated.

RESULTS

VIBE sensitivity in lung nodules evaluation was 80% (8/10 patients) for nodules >5 mm and 57,1 % (4/7 patients) for nodules <= 5 mm, compared to CT imaging. In both cases specificity was 100%. All dense bands and parenchymal consolidation were found both with CT scan and VIBE. Inter-observer agreement was 95 % for nodules >5 mm (κ =0.90, $p<0.001$), 85% for nodules <= 5 mm (κ=0.44 $p<0.005$), 90% for dense bands (κ =0.56, $p<0.001$) and 100% for parenchymal consolidations.

CONCLUSION

VIBE showed high sensitivity in the evaluation of lung nodules > 5 mm; sensitivity was less satisfactory for smaller nodules. This sequence obtained also a very good inter-observer agreement, resulting a very reproducible imaging technique in pulmonary lesion investigation. Considering also the short acquisition time (15-18 s), it seems be reasonable to integrate PET/MRI protocols with a short TE and low FA VIBE, improving its diagnostic performance in lung evaluation.

CLINICAL RELEVANCE/APPLICATION

Short TE and low FA VIBE sequence can improve PET-MRI diagnostic performance in pulmonary lesions detection, without a significant increase in the acquisition time.

SST07-07 Relative Effect Size of Different Clinical & PET Variables on NSCLC Patient's Survival Estimated with Random Survival Forest Model

Friday, Dec. 1 11:30AM - 11:40AM Room: E353C

Participants
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PURPOSE

To assess relative effect size of the different clinical & PET variables on the overall survival (OS) in patients with non-small cell lung cancer (NSCLC), using permutation Variable Importance (VIMP) measure with a Random Survival Forest (RSF) model.

METHOD AND MATERIALS

A RSF model, which can address right censored data problem, was constructed based on 952 Consecutive NSCLC patients with baseline PET/CT studies, but no brain metastasis or other type of primary cancer (separated into 604 for training and 348 for testing, according to their PET/CT study acquisition scanners). The RSF model included gender, age, race, smoking status, TNM stage (according to the 8th edition of the clinical TNM staging system), histology type, treatment types (with surgery, without surgery and no treatment), and maximum standard uptake value of whole-body tumor (SUVmaxWB) and whole-body metabolic

tumor volume (MTVWB) measured on the PET/CT studies. The overall survival (OS) time served as independent variable. The VIMP, which is a measure of relative importance of parameters on survival (the higher value indicates higher importance), was calculated using permutation method included in the RSF R package (randomForestSRC). The trained RSF model was used to predict the survival rate for the patients in the test dataset and the results were compared to the standard Cox model.

RESULTS

The top 3 highest VIMP coefficients of 0.047, 0.036 and 0.032, were from treatment type, clinical TNM stage and MTVWB, respectively. The coefficient of SUVmaxWB was 0.011. The histology type, race, smoking status and gender had similar coefficients of about 0.003, while age had the smallest VIMP of 0.001. When predicting the test patients' survival rate with the identical variables, our RSF model achieved moderate performance with C-index (a measure of predictive ability of a model) of 0.73, compared to 0.71 by the Cox model.

CONCLUSION

Our model suggests that treatment types, TNM stage and MTVWB are relatively important variables on NSCLC patient's survival, among the commonly used clinical prognostic and PET tumor variables. SUVmaxWB has a moderate effect, while the histology type, race, smoking status, gender and age have small effect on patients overall survival.

CLINICAL RELEVANCE/APPLICATION

This work suggests that treatment type, TNM stage, MTVWB and SUVmaxWB are important prognostic factors useful for the treatment decision making and prognosis of NSCLC patients.

SST07-08 Active Contour-Based Segmentation for 18F-FDG PET Thoracic Oncology: A Powerful Alternative to the Clinical State-of-the-Art Expert-Based Segmentation

Friday, Dec. 1 11:40AM - 11:50AM Room: E353C

Participants
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PURPOSE

The aim of this study was to assess the performances of an active contour-based user GUI approach for the PET segmentation of complex-shaped lung tumours, in comparison to an optimized expert-based manual reference standard.

METHOD AND MATERIALS

In this retrospective study, 75 complex-shaped lung tumours were blindly segmented using the same graphical user interface (GUI) ITK snap software. For each tumour, four independent raters semi-automatically segmented the 75 tumours twice (sessions 1 and 2) using the active contour based-procedure of the GUI software. A probabilistic estimate of each tumour ground truth was also computed from the set of six independent expert-based manual segmentation results using the Simultaneous Truth And Performance Level Estimate (STAPLE) algorithm. Accuracy of the semi-automatic procedure was assessed by measuring the spatial overlap between the raters segmentation outputs and the corresponding expert probabilistic reference standards, using the DICE similarity coefficient (DSC). Interrater and intrarater reliability analyses were also performed using the intra class correlation coefficients (ICC) estimates of the output volumes,(two-way mixed-model, individual-rating, absolute-agreement). For all tumours segmentation procedures, average time per procedure was also estimated.

RESULTS

Overall accuracy of the user GUI active contour-based procedure was excellent with a DSC of 0.835 (95%CI = 0.775-0.895). Interrater reliabilities provided the following results: ICC = 0.941 (95%CI = 0.913-0.961) for the first session and ICC = 0.935 (95%CI = 0.906-0.956) for the second session. Intrarater reliabilities provided the following results: ICC = 0.993 (95%CI = 0.990-0.996) for the rater 1; ICC = 0.987 (95%CI = 0.976-0.993) for the rater 2; ICC = 0.972 (95%CI = 0.956-0.982) for the rater 3; and ICC = 0.977 (95%CI = 0.964-0.985) for the rater 4. Average time was 631 seconds for manual segmentation procedure, and 130 seconds for active contour-based procedure.

CONCLUSION

Compared to the state of the art expert-based manual segmentation, the GUI-based active contour procedure provided excellent accuracy and reliability, with a mean procedure duration almost five-times faster than the manual reference standard.

CLINICAL RELEVANCE/APPLICATION

Active contour-based segmentation from ITK-snap software is robust, fast, and easy enough to be routinely applied to segment

Active contour based-segmentation from ITK snap software is robust, fast, and easy enough to be routinely applied to segment heterogeneous and complex-shaped lung tumours.

SST07-09 FDG-PET/CT Predicts Development of Thyroiditis due to Immunotherapy for Lung Cancer

Friday, Dec. 1 11:50AM - 12:00PM Room: E353C

Participants
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PURPOSE

Determine if PET/CT parameters of FDG uptake in the thyroid gland pre-and post-immunotherapy with nivolumab for advanced lung cancer could predict the development of the immune-related adverse event, thyroiditis.

METHOD AND MATERIALS

An IRB-approved retrospective chart review over 2 years found 18 patients with advanced lung cancer treated with nivolumab and with FDG-PET/CT scans pre and post therapy. The post-treatment FDG-PET/CT was performed approximately 6-9 weeks after the first dose of nivolumab. The standardized uptake value (mean and max) and total lesion glycolysis (TLG) of the thyroid gland were measured. Patients obtained monthly thyroid function testing as standard of care while receiving nivolumab. Results of the thyroid testing separated the patients into two groups, patients who developed new hypothyroidism (thyroiditis) and those who did not. Statistical t-test analysis used the FDG-PET/CT parameters to compare the two groups.

RESULTS

In the hypothyroid group, 7 patients developed hypothyroidism after immunotherapy. In the euthyroid group, 9 patients remained euthyroid and 2 patients had a pre-existing history of hypothyroidism (including these 2 did not significantly affect statistics). T-test analysis demonstrated statistically significant higher post-therapy SUVs in the hypothyroid versus euthyroid group. The differences in average values between the two groups were SUV mean 0.77 ($p<0.04$), SUV max 0.96 ($p<0.04$) and TLG 0.96 ($p<0.02$). Pre-therapy SUVs showed no statistical difference. 4 out of 7 patients in the hypothyroid group were euthyroid at the time of the post-therapy PET scan and developed hypothyroidism months later.

CONCLUSION

Nivolumab is an immune checkpoint inhibitor which works by activation of T cells against tumors and is associated with immune-related adverse events like thyroiditis. Increases in FDG uptake in the thyroid gland after immunotherapy indicate inflammation from thyroiditis and therefore predict the development of immunotherapy-induced hypothyroidism, potentially before laboratory testing or development of symptoms.

CLINICAL RELEVANCE/APPLICATION

FDG-PET/CT can predict the development of immunotherapy-induced hypothyroidism and therefore the necessity for thyroid hormone replacement.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Elizabeth A. Krupinski, PhD - 2017 Honored Educator

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103rd Scientific Assembly and Annual Meeting
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McCormick Place, Chicago
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SST08

Neuroradiology/Head and Neck (Head and Neck Imaging: Testing the Limits)

Friday, Dec. 1 10:30AM - 12:00PM Room: E353A

NR HN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Brent D. Griffith, MD, Troy, MI (*Moderator*) Nothing to Disclose
Amanda S. Corey, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

Sub-Events

SST08-01 Surgical Reconstruction of Ossicular Chain Defect with Custom 3D Printed Ossicular Prosthesis

Friday, Dec. 1 10:30AM - 10:40AM Room: E353A

Participants
Jeffrey D. Hirsch, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
David Eisenman, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Conductive hearing loss due to ossicular abnormalities occurs from many causes, including trauma, infection, cholesteatoma, surgery and congenital anomalies. Surgical reconstruction of the ossicular chain is a well-established procedure for repair of ossicular defects, but is still plagued by high failure rates. Underlying disease and proper sizing of prostheses are two challenges that lead to component failure. Three-dimensional (3D) printing has been used successfully to solve a number of medical prosthesis problems. Custom 3D printing an individualized ossicular prosthesis would be a potential solution for the wide range of anatomic variation encountered in the pathological middle ear, and could decrease the rate of post-operative prosthesis displacement by increasing the likelihood of a proper fit, in addition to decreasing surgical time.

METHOD AND MATERIALS

The incus was removed from three formalin-fixed cadaveric human temporal bones with no macro- or microscopic evidence of pathology. Imaging of the cadaveric bone was obtained using a standard temporal bone CT protocol. A custom prosthesis for each cadaveric human temporal bone was designed using the Mimics Innovation Suite software (Materialise, Belgium) and fabricated on a Form2 3D printer (FormLabs, Somerville, Massachusetts). Four surgeons then performed insertion of each prosthesis into each middle ear, blinded to the bone from and for which each was designed. The surgeons were asked to match each prosthesis to its correct parent bone.

RESULTS

Each prosthesis had unique measurements. Each of the four surgeons was able to correctly match the prosthesis model to its intended temporal bone. The chances of this occurring randomly are 1:1296.

CONCLUSION

A custom 3D printed ossicular prosthesis is a viable solution for conductive hearing loss due to ossicular chain defects. Commercially available CT scanners can detect significant anatomic differences in normal human middle ear ossicles. These differences can be accurately represented with current 3D printing technology and, more significantly, surgeons can detect these differences.

CLINICAL RELEVANCE/APPLICATION

This process overcomes a common technical challenge of properly sizing the prosthesis, as each model is custom made for an exact fit which should lead to an improved result and decreased operative time.

SST08-02 Assessment of Microvascular Compression for Facial-Acoustic Nerves: Role of Combined Isotropic 3D T2-DRIVE and 3D TOFMRA

Friday, Dec. 1 10:40AM - 10:50AM Room: E353A

Participants
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PURPOSE

To evaluate the application value of isotropic 3D T2-DRIVE combining isotropic 3D TOFMRA in detecting microvascular compression for facial-acoustic nerves.

METHOD AND MATERIALS

Thirty-six patients were enrolled in the study with clinically suspected vascular compression of facial-acoustic nerves, of which both 3D T2-DRIVE and 3D TOFMRA sequences images were obtained of isotropy and identical voxel size at 0.7 mm×0.7 mm×0.7 mm. Source images and reformatted images were observed to evaluate the effects on demonstration of facial-acoustic nerves and culprit vessels, which was scored from 0 to 3 points in the order from poor to excellent. The differences were compared of effects on displaying both the facial-acoustic nerves and culprit vessels among the three approaches of 3D T2-DRIVE, 3D TOFMRA, and 3D T2-DRIVE+3D TOFMRA. The Kruskal-Wallis H test was employed in data processing, with $P<0.01$ for the statistically significant difference.

RESULTS

In displaying facial-acoustic nerves, 3D T2-DRIVE+3D TOFMRA and T2 3D-DRIVE were superior to 3D TOFMRA (H=58.78, P=0.0000. H=53.18, P=0.0000.respectively), and no statistically significant difference existed between 3D T2-DRIVE+3D TOFMRA and T2 3D-DRIVE (H=2.28, P=0.1313). In displaying culprit vessels, 3D-T2-DRIVE+3D TOFMRA was superior to T2 3D-DRIVE and 3D TOFMRA (H=54.12,P=0.0000. H=62.42, P=0.0000. respectively), and no statistically significant difference existed between 3D T2-DRIVE and 3D TOFMRA (H=0.0083, P=0.9274). Of 36 patients, 32 were detected with arteriolar compression for facial-acoustic nerves by the approach of 3D T2-DRIVE combining 3D TOFMRA, and 4 with no compression. The results were confirmed by surgical findings or clinical follow-up, respectively. The sensitivity and specificity was 100%, 100% of 3D T2-DRIVE+3D TOFMRA in diagnosing microvascular compression for facial-acoustic nerves, respectively.

CONCLUSION

The combination of isotropic 3D T2-DRIVE and isotropic 3D TOFMRA provides a precise and accurate diagnostic approach in identifying micorvascular compression for facial-acoustic nerves.

CLINICAL RELEVANCE/APPLICATION

Combined isotropic 3D T2-DRIVE and 3D TOFMRA has advantage over isotropic 3D T2-DRIVE in detecting micorvascular compression for facial-acoustic nerves, and over isotropic 3D TOFMRA as well. The approach could be widely utilized in the radiologically diagnostic scenario of potential microvascular compression for cranial nerves.

SST08-03 Static and Dynamic Evaluation with MRI of Larynx and Oro-Pharingeal Cavity in Professional Opera Singers

Friday, Dec. 1 10:50AM - 11:00AM Room: E353A

Participants
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PURPOSE

To assess the anatomical configuration of phonetic organs by MRI in professional opera singers with different vocal range.

METHOD AND MATERIALS

26 professional opera singers (12 men (7 tenors and 5 basses) and 14 women (8 sopranos and 6 mezzosopranos) were evaluated with MRI. We performed both static and dynamic study with MRI. The static study was performed with TSE T2-weighted axial scans at the level of larynx (TR:2000 ms; TE:120ms; slice thick:3mm) in order to evaluate the area of superior surface of vocal cord. In the dynamic study, the singers were asked to perform a prolonged vocalization at a confortable tonality of the fundamental vowel a. We performed a midsagittal Turbo Field Echo scan (TR:12ms; TE:6ms; fa:30°; acq.time:6s) at the level of the oro-pharyngeal cavity measuring the area of the mouth and pharyngeal lumen. These data underwent statistical evaluation using the Mann-Whitney U-test (non-parametric test) considering: 1) vocal tessitura; 2) size of the vocal cord; 3) area of the mouth and pharyngeal lumen during the utterance of the vowel a.

RESULTS

The average size of the vocal cord was: 0.71 cm2 for sopranos; 1.20 cm2 for mezzosopranos; 1.58 cm2 for tenors; 2.88 cm2 for basses. The average area of mouth and pharyngeal lumen on midsagittal scan during the utterance of the vowel a was: 15.8 cm2 for sopranos; 14.6 cm2 for mezzosopranos; 23.6 cm2 for tenors; 32.2 cm2 for basses. We found that the differences in vocal cord size between sopranos and mezzosopranos (P: 0.0641) and between tenors and basses (P: 0.0833) are tendentially statistically significant. The variation in vocal tract size during the utterance of the vowel a between tenors and basses is considered tendentially statistically significant (P: 0.0833) while the difference between sopranos and mezzosopranos is not considered statistically significant (P: 0.6434). The difference in the vocal register between soprano and mezzosoprano is less considerable in comparison with tenor and bass or with soprano and contralto.

CONCLUSION

Our results demonstrate a correlation between the surface of the vocal cord and the configuration of vocal tract and the vocal tessitura of a singer.

CLINICAL RELEVANCE/APPLICATION

Long vocal cord and wide vocal tract are characteristic of singers with low-pitched voice types (bass, baritone, contralto) while short vocal cord and narrow vocal tract are characteristic of singers with high-pitched voice types (tenor, soprano).

SST08-04 Basic Consideration for Facial Aging: Anatomic and Radiological Analysis of the Superficial Musculoaponeurotic System (SMAS)

Friday, Dec. 1 11:00AM - 11:10AM Room: E353A

Participants
Itsuko Okuda, MD, Minato-Ku, Japan (*Presenter*) Nothing to Disclose
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Keiichi Akita, MD, PhD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Facial aging is caused not only by skin aging, but also by aging changes of the subcutaneous structures. The SMAS is situated in the superficial fascia. SMAS weakness was reported as one factor of cheek sagging related with facial aging. The purpose of this study is to analyze the anatomic radiological correlation of the SMAS, and establish CT findings of the SMAS.

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board. Step 1: five cadaver faces were used to confirm the morphology and distribution of the SMAS. Right halves of those were dissected, and examined the structures of SMAS. The left were used for cross-sectional anatomic and histological examinations. Step 2: To select the interpretation sites of the SMAS, the SMAS's findings of the cadaveric studies were compared to the CT findings. Step 3: To confirm CT findings of SMAS, CT images of 18 females (age range, 21-82 years) without lesions that would influence the superficial structures of their faces were enrolled. Two observers assessed CT findings of the SMAS independently, and the criteria was used for the following three-grade scales: G-2 (entire visualization as a thick layer); G-1 (entire visualization as a thin layer); or G-0 (obscured or partial visualization as a thin layer). The interobserver differences were assessed by kappa coefficient.

RESULTS

The SMAS was observed as a subcutaneous fibro-membranous structure extending from the superficial temporal fascia to the parotid fascia, and contained the major and minor zygomatic muscles and platysma. CT showed the subcutaneous linear opacities corresponding to the fibro-membranous structures of the cadaveric studies. Among the 18 cases, observer 1 judged G-2:11, G-1:7, G-0:0. Observer 2 judged G-2:13, G-1:5, G-0:0. There was good agreement between 2 observers about CT findings of SMAS (kappa=0.75, p **CONCLUSION**

The SMAS is a definite anatomic structure that can be demonstrated as an anatomic membranous layer in subcutaneous adipose tissue from the superficial temporal fascia to the parotid fascia on CT. This analysis is applicable to evaluating age-related changes of the face, and can contribute to the elucidation of the mechanism of facial aging.

CLINICAL RELEVANCE/APPLICATION

CT is the useful tool to evaluate the SMAS that is important structures to maintain a young appearance, and clinical applications can contribute to the elucidation of the mechanism for facial aging.

SST08-05 CT Texture Analysis of Lymphoid Tissues on FDG-PET/CT in HIV-positive Patient

Friday, Dec. 1 11:10AM - 11:20AM Room: E353A

Participants
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PURPOSE

Differentiating lymphoid malignancy from reactive lymphoid tissue in HIV-infected patients with 18F-FDG PET/CT can be challenging as increased FDG uptake secondary to inflammation and infection may cause false-positive results for assessment of lymphoid tissue, such as palatine tonsils. The purpose of this study was to assess the utility of CT texture analysis characteristics of lymphoid tissues in HIV-positive patients on 18F-FDG-PET/CT in making the distinction between malignancy and non-neoplastic process with increased FDG uptake.

METHOD AND MATERIALS

Fifty-eight HIV-positive patients (age 9-80 years; median age, 48 years; median absolute CD4 count, 237 cells/mm3 [range; 17-1900]) who underwent contrast-enhanced CT with 18F-FDG-PET for various reasons were retrospectively reviewed. The whole normal right palatine tonsil was segmented on CT and texture analysis was performed using an in-house MATLAB-based texture analysis program. Forty-two texture features were extracted, including histogram-based, gray-level co-occurrence matrix-based (GLCM), gray-level run-length-based features (GLRL), gray level gradient matrix (GLGM), and Laws' features from the segmented volume. SUVmax values of the right palatine tonsil were obtained by manual selection of the lymphoid tissue at a PET/CT workstation. Multiple regression analyses were performed to assess the association between 42 texture features and the SUVmax value in palatine tonsil with adjustments for age and absolute CD4 cell counts.

RESULTS

The median SUVmax in normal tonsil of HIV positive patients was 4.4 (range, 1.2-10.4). Significant correlation were seen in 2 GLCM features [entropy (*P*=.039) and homogeneity (*P*=.008)], 7 GLRL features [RP (*P*=.018), LGRE (*P*=.019), HGRE (*P*=.018), SRLGE (*P*=.019), SRHGE (*P*=.001), LRLGE (*P*=.001), LRHGE (*P*=.003), 7 Law's features [L1 (*P*=.040), L2 (*P*=.002), L3 (*P*=.033), L4 (*P*=.003), L5 (*P*=.043), L7 (*P*=.042) L9 (*P*=.037)] and 4 GLGM features [MGR (*P*<.001), VGR (*P*<.001), skewness (*P*<.001) and kurtosis (*P*<.001)] with tonsil SUVmax value. There was no significant correlation between texture features and absolute CD4 cell counts in this model.

CONCLUSION

Lymphoid tissue CT texture analysis parameters are associated with abnormal FDG uptake in patients with HIV.

CLINICAL RELEVANCE/APPLICATION

CT texture analysis may be used as a type of noninvasive imaging biomarker capable of detecting obscure lymphoid inflammation in HIV positive patient.

SST08-06 Ultrasound and Clinicopathological Features of Papillary Thyroid Carcinomas with BRAF and TERT Promoter Mutations

Friday, Dec. 1 11:20AM - 11:30AM Room: E353A

Participants
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PURPOSE

To investigate if any relationship exists between the telomerase reverse transcriptase (TERT) promoter or BRAF mutation and ultrasound (US) and clinicopathological features of papillary thyroid carcinomas (PTCs).

METHOD AND MATERIALS

The Institutional Review Board approved the study protocol and the use of human thyroid tissue. The study included 150 patients with surgically confirmed PTC from October 1994 to December 2004. The mean clinical and imaging follow up periods were 149.6 ± 24.6 and 143.1 ± 34.5 months, respectively. According to the existence of TERT promoter or BRAF mutations, we categorized patients into three groups (no mutation, BRAF mutation alone, or TERT+BRAF mutations) and analyzed the relationships between TERT promoter or BRAF mutation and US and clinicopathological features using uni- and multinomial logistic regression analysis and Cochran-Armitage trend test. The rate of recurrence or death according to mutation analysis was estimated by the Kaplan-Meier method.

RESULTS

There were 35 (23.3%) cases with no mutation, 104 (69.3%) with BRAF mutation alone, and 11 (7.3%) with TERT+BRAF mutations. According to the results of the Cochran-Armitage trend test, as the number of genetic mutations increased from no mutation to BRAF mutation alone to both BRAF and TERT mutations, the proportions of hypoechogenicity (31.4% vs. 66.4% vs. 54.5%, P = .0066), non-parallel orientation (25.7% vs. 49.0% vs. 72.7%, P = .0023), spiculated/microlobulated margin (45.7% vs. 51.9% vs. 90.9%, P = .0364), microcalcifications (62.9% vs. 72.1% vs. 90.9%, P = .0822), and K-TIRADS category 5 (48.6% vs. 71.1% vs. 63.6%, P = .0670) increased. PTCs with TERT+BRAF mutations recurred more frequently than other groups (odd ratio [OR] = 17.921 and 31.468). The intervals to recurrence and overall survival were significantly shorter in the TERT+BRAF mutation group than in the other groups (P < .0001 and P < .0001).

CONCLUSION

PTCs with no mutation, with BRAF mutation alone, and with both TERT and BRAF mutations linearly increase in the probability of displaying malignant US features. In PTCs, the coexistence of BRAF with TERT mutations is more strongly correlated with recurrence and mortality than BRAF mutation alone.

CLINICAL RELEVANCE/APPLICATION

US imaging characteristics of PTCs based on molecular biomarkers including BRAF and TERT promoter mutations can serve as predictors of patient prognosis.

SST08-07 Oral Carcinoma: Clinical Evaluation using Diffusion Kurtosis Imaging and its Correlation with Histopathologic Findings

Friday, Dec. 1 11:30AM - 11:40AM Room: E353A

Participants
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PURPOSE

To determine the clinical usefulness of diffusion kurtosis imaging (DKI) for patients with oral carcinoma as a noninvasive method of evaluating the histologic grades of oral carcinomas and lymph node metastasis by oral carcinomas.

METHOD AND MATERIALS

Twenty patients with oral carcinoma were examined with a 3-T MR system equipped with a 16-channel head and neck coil. DKI data were obtained by using a spin echo-based single-shot echo-planar imaging sequence: repetition time, 10000 ms; echo time, 94 ms; field of view, 250 mm x 204.25 mm; matrix, 120 x 98; section thickness, 4 mm without intersection gaps; four b values of 0, 500, 1000, and 2000 s/mm2; and motion-probing gradients set along three orthogonal directions. Diffusivity (D) and kurtosis (K) were calculated by using the equation: $S = S0 \bullet \exp(-b \bullet D + b2 \bullet D2 \bullet K/6)$, and standard apparent diffusion coefficient (ADC) was also calculated by using the conventional monoexponential fit. The MR images were then compared with the histopathologic findings as the reference standard.

RESULTS

In all 20 oral carcinomas, the diffusivity was calculated as 1.777 ± 0.377 x 10-3 mm2/s, kurtosis 0.839 ± 0.130 (arbitrary unit [a.u.]), and ADC 0.790 ± 0.089 x 10-3 mm2/s. With the histologic grades (Grades 1, 2, and 3) of the oral carcinomas, the diffusivity showed a statistically significant inverse correlation ($r = -0.893$; $P < 0.001$) and the kurtosis showed a statistically significant positive correlation ($r = 0.851$; $P < 0.001$), while the ADC showed no significant correlation ($r = -0.341$; $P = 0.196$). Furthermore, between metastatic lymph nodes and nonmetastatic lymph nodes, the diffusivity (1.365 ± 0.395 vs. 1.985 ± 0.540 x 10-3 mm2/s; $P < 0.05$) and kurtosis (1.110 ± 0.242 vs. 0.746 ± 0.078; $P < 0.01$) showed statistically significant differences, while the ADC (0.726 ± 0.071 vs. 0.787 ± 0.056 x 10-3 mm2/s; $P = 0.127$) showed no significant differences.

CONCLUSION

In patients with oral carcinoma, DKI seems to be clinically useful for evaluating the histologic grades of oral carcinomas and lymph node metastasis by oral carcinomas.

CLINICAL RELEVANCE/APPLICATION

By using DKI for patients with oral carcinoma, we may have an effective tool to noninvasively diagnose the histologic grades of oral carcinomas and lymph node metastasis by oral carcinomas.

SST08-08 Computed Diffusion Weighted Imaging with Noise Reduction: Utility in Diagnosing Middle Ear Cholesteatoma

Friday, Dec. 1 11:40AM - 11:50AM Room: E353A

Participants
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PURPOSE

To evaluate whether computed DWI (cDWI) with noise reduction increases the contrast-to-noise ratio (CNR) compare to that without noise reduction algorithm in middle ear cholesteatoma.

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board, and the requirement for informed consent was waived. Consecutive patients diagnosed with suspected cholesteatoma who underwent preoperative MR imaging between October 2014 and August 2016 were eligible for inclusion. cDWI (b = 800 sec/mm2) was generated from two b-values of 0 and 400 sec/mm2 by voxel wise fitting on a 3D workstation (Ziostation2). Noise reduction was performed by the cutoff values of ADC < 0 (ADC0) and 0.4 × 10-3mm2/sec (ADC0.4). Region-of-interests were manually placed on the cholesteatoma and background, respectively. Subsequently, the CNR was compared between ADC0, ADC0.4, and the control (without noise reduction algorithm) using one-way ANOVA followed by the Bonferroni correction for multiple comparison.

RESULTS

The study group consisted of 25 patients (M:F = 14:11, median age = 51 years). The CNR of ADC0 (mean ± SD = 6.72 ± 1.77) and ADC0.4 (mean ± SD = 7.00 ± 2.21) were significantly higher than those of the control (mean ± SD = 5.17 ± 1.43; $p < 0.01$ and $p < 0.001$, respectively).

CONCLUSION

The cholesteatoma-background CNR was increased using a noise reduction algorithm for cDWI.

CLINICAL RELEVANCE/APPLICATION

The computed DWI (cDWI) with noise reduction algorithm may be useful to distinguish cholesteatoma from adjacent soft tissues such as granulation or fibrous tissue. The increase of CNR could improve in the diagnostic accuracy of cholesteeatoma.

SST08-09 Intravoxel Incoherent Motion Magnetic Resonance Imaging of the Normal-Appearing Parotid Glands in Patients with Differentiated Thyroid Cancer After Radioiodine Therapy

Friday, Dec. 1 11:50AM - 12:00PM Room: E353A

Participants
Xiao_quan Xu, Nanjing, China (*Presenter*) Nothing to Disclose

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PURPOSE

Radiation damage to the salivary gland is a common complication of radioiodine therapy (RIT) in the patients with differentiated thyroid cancer (DTC). To investigate the feasibility of using intravoxel incoherent motion (IVIM) magnetic resonance (MR) imaging to detect radiation-induced changes of normal-appearing parotid glands in the patients after RIT for DTC.

METHOD AND MATERIALS

We prospectively enrolled 20 patients with RIT-induced sialoadenitis and 20 healthy control (HC) participants. The patients were divided into intermediate and late groups, and questionnaire was used to assess the related symptoms. IVIM MR imaging was scanned using 9 b values (0, 50, 100, 150, 200, 400, 600, 800 and 1000 sec/mm2). Quantitative parameters (pseudodiffusion coefficient, D*; perfusion fraction, f; tissue diffusivity, D) were obtained using a biexponential model, and compared among different groups using one-way analysis of variance (ANOVA) test. Correlations between significant parameters and symptom score were assessed using Spearman's correlation analysis.

RESULTS

The f and D value differed significantly (f, P=0.016; D, P=0.006) among different groups. Post hoc analysis showed that f and D value of intermediate group were significantly higher than those of HC group (f, P=0.012; D, P=0.004), while no significant differences between late group and HC group (f, P=0.852; D, P=0.707). Significant positive correlation was found between f value and the total symptom score of the patients in intermediate group (P=0.028, r=0.762).

CONCLUSION

The IVIM MR imaging might be feasible to detect the radiation-induced changes of parotid glands in the patients after RIT for DTC.

CLINICAL RELEVANCE/APPLICATION

Our study showed that both the perfusion fraction f and tissue diffusivity D of intermediate group were higher than the HC group. Perfusion fraction f had a significant correlation with symptom score. Our study results demonstrated that IVIM MR imaging was feasible to detect the radiation-induced changes of parotid glands of the patients after radioiodine therapy for DTC.

SST09

Pediatrics (Neuroradiology)

Friday, Dec. 1 10:30AM - 12:00PM Room: E350

NR PD

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Bernard F. Laya, DO, Lincoln, IL (*Moderator*) Nothing to Disclose
Usha D. Nagaraj, MD, Cincinnati, OH (*Moderator*) Co-author with royalties, Reed Elsevier

Sub-Events

SST09-01 Quantitative Measurement of Cerebral Blood Flow in Preterm by Multiple Inversion Time Arterial Spin Labeling Magnetic Resonance Imaging: Initial Study

Friday, Dec. 1 10:30AM - 10:40AM Room: E350

Participants
Hong Wang, Suzhou, China (*Presenter*) Nothing to Disclose
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PURPOSE

To investigate the influence of cerebral blood flow in preterm with perinatal asphyxia using multiple inversion time arterial spin labeling(mTI-ASL) technique.

METHOD AND MATERIALS

A total of 40 preterm infants at term-equivalent age underwent MRI examination in the study. A MRI examination including mTI-ASL prototype sequence and other conventional plain sequences was performed on MAGNETOM Skyra (Siemens Healthcare, Erlangen, Germany). According to clinical history and MR diagnosis, 40 preterm infants were divided into three groups: group1 (n=14, no brain injury without perinatal asphyxia), group 2 (n=12, no brain injury with perinatal asphyxia) and group 3 (n=14, brain injury with prenatal asphyxia). Mean cerebral blood flow(CBF) values from ROIs drawn in the basal ganglia and thalami (BGT), gray matter (GM) including frontal lobe, temporal lobe and occipital lobe, and white matter (WM)were calculated and analyzed by SPSS 21.0 statistical software. CBF values for each ROIs were analyzed by one-way ANOVA across groups. And then if $P < 0.05$, q test for multiple comparison with SNK would be conducted.

RESULTS

The difference of CBFBGT and CBFGM was statistically significant between Group 1 and Group 2 ($P < 0.05$). The differences of CBFBGT, CBFGM and CBFWM were statistically significant between Group 2 and Group 3 (CBFBGT: $P < 0.01$; CBFGM, CBFWM: $P < 0.05$). However, the difference of CBFWM between Group 1 and Group 2 was not statistically significant. And CBFBGT, CBFGM, CBFWM between Group 1 and Group 3 were not statistically significant. In group1, the difference of CBF was statistically significant between frontal lobe and occipital lobe, between temporal lobe and occipital lobe, whereas the difference of CBF was not statistically significant between frontal lobe and temporal lobe.

CONCLUSION

mTI-ASL is a noninvasive MR method for accurately measuring CBF in neonates. Autoregulation of the cerebral blood flow has association with the outcome of preterm infants with perinatal asphyxia. Perinatal asphyxia may affect the regional regulation of CBF in gray matter.

CLINICAL RELEVANCE/APPLICATION

mTI-ASL is a feasible approach to measuring brain perfusion and it offers the possibility to investigate the impact of cerebral hemodynamics in high-risk preterm infants.

SST09-02 Acute Ischemic Stroke in Patients Younger than 18: Why Not Wide the Therapeutic Window for Mechanical Thrombectomy?

Friday, Dec. 1 10:40AM - 10:50AM Room: E350

Awards
Student Travel Stipend Award

Participants
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PURPOSE

This study aimed to analyze the safeness and effectiveness of endovascular approach in pediatric intracranial recanalization and to propose a diagnostic and therapeutic algorithm for patients younger than 18 with acute ischemic stroke based on our experience.

METHOD AND MATERIALS

We studied patients prospectively included in SONIIA registry (2011-2015), a mandatory, externally audited registry that monitors the quality of reperfusion therapies in Catalonia. Clinical evaluation: neurological severity, functional independence. Radiological examination: multimodal CT/MRI. Treatment criteria: clinical-radiological mismatch. Analysis and outcome parameters: successful recanalization (TICI >=2b), dramatic neurological improvement (>=10 points decrease in NIHSS score at 24 hours), independent functional outcome (mRS <=2) at three months.

RESULTS

Among the 1640 patients included, mechanical thrombectomy occurred in five. Mean age was 14.6±1.6, four female. Median NIHSS score: 13 (7-19) on arrival, 4 (1-5) at 24 hours. Underlying diseases: Osler-Weber-Rendu (n=1), congenital heart defect (n=1), none (n=3). Etiology: iatrogenic (n=1), non-compliance of anticoagulation (n=1), idiopathic (n=3). Clinical presentation: hemiparesis (n=4), aphasia (n=1). We used the neuroimaging standard protocol during acute ischemic stroke: multimodal CT (n=3), multimodal MRI (n=2). Occlusion site: internal carotid artery (n=2), middle cerebral artery (n=2), basilar artery (n=1). We combined stent-retriever technology plus distal aspiration in four patients (median number of passes: 2), direct aspiration first pass technique in one (duration of aspiration: 30 s). Procedural time: 68.4±26.4 min. All patients achieved successful recanalization. All procedures resulted in functional independence. No complications were reported.

CONCLUSION

The presence of a clinical-radiological mismatch in acute ischemic stroke patients younger than 18 should let us consider an "aggressive treatment", such as mechanical thrombectomy, as it allows safe, effective, and prompt recanalization. The MRI should be the diagnostic technique in all types of stroke, diagnosing underlying conditions while reducing radiation exposure.

CLINICAL RELEVANCE/APPLICATION

Acute ischemic stroke in children is difficult to diagnose and manage due to atypical presentation and imaging challenge. There is a lack of evidence-based data concerning mechanical thrombectomy for patients younger than 18 years old.

SST09-03 Multi-Delay Arterial Spin Labeling MRI in Neonates: Regional Differences and Changes in Brain Perfusion during Brain Maturation

Friday, Dec. 1 10:50AM - 11:00AM Room: E350

Participants
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PURPOSE

The purpose of this study was to evaluate cerebral blood flow (CBF) in neonates using multi-delay arterial spin labeling (ASL).

METHOD AND MATERIALS

A 7 post-labeling delay pseudo-continuous ASL was applied on 20 neonates (6 preterm vs. 14 term-equivalent age [TEA]) and 4 infants (mean age, 3 months). We adjusted longitudinal relaxation rate of blood in each patient with hematocrit values. CBF in the thalamus, frontal gray matter (F_GM), occipital gray matter (O_GM), frontal white matter (F_WM), and occipital white matter (O_WM) were measured in ml/100g min and relative CBF (rCBF) to that of the whole brain CBF (wbCBF) were calculated.

RESULTS

In all neonates, CBF of O_WM was significantly higher than F_WM (16.5ml/100g min vs. 12.2ml/100g min, p = .001), but CBF of O_GM and F_GM showed no significant difference (26.2ml/100g min vs. 27.5ml/100g min, p = .253). Mean wbCBF significantly increased from 13.4ml/100g min at preterm to 18.0ml/100g min at TEA (p = .009) and it further increased to 32.8ml/100g min at 3 months (p = .001). From preterm to TEA, there was significant decrease of rCBF of thalamus (252% to 197%, p = 0.02) and F_GM (160% to 122%, p = .026) and significant increase of rCBF of O_GM (163% to 125%, p = .015). From TEA to 3 months, rCBF were significantly decreased in thalamus (197% to 140%, p = .046), F_WM (108% to 57%, p = .001), and O_WM (139% to 79%, p = .003).

CONCLUSION

Multi-delay ASL showed differences and changes in regional CBF in neonates and infants, which may reflect metabolic and developmental stages of brain.

CLINICAL RELEVANCE/APPLICATION

Multi-delay ASL can be a non-invasive tool to study brain maturation in neonates.Cerebral perfusion changes by hypoxic ischemic injury in neonates can further investigated with multi-delay ASL.

SST09-04 Expression Changes in Lactate and Glucose Metabolism and Associated Transporters in Basal Ganglia Following Hypoxic-Ischemic Reperfusion Injury in Piglets

Friday, Dec. 1 11:00AM - 11:10AM Room: E350

Participants
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PURPOSE

To investigate the regulatory mechanisms of energy metabolism in neurons and astrocytes in the basal ganglia of a neonatal hypoxic-ischemic brain injury piglet model.

METHOD AND MATERIALS

A total of 35 healthy piglets (3-5 days old, 1.0-1.5 kg) were selected. They were divided into control (n=5) and hypoxic-ischemic (HI) model groups. The HI model group was further divided into six groups according to 1H- MRS and PET/CT scan times after HI (0-2 h, 2-6 h, 6-12 h, 12-24 h, 24-48 h and 48-72 h; n = 5/group). The HI model was established by bilateral common carotid artery occlusion and simultaneous hypoxia treatment for 40 min. Piglets in the control group received the same surgical procedure without the hypoxia-ischemia process. 1H-MRS and 18F- FDG PET/CT imaging were performed at various time points after HI. The right basal ganglia were the ROI in 1H-MRS imaging for which data was processed by LCModel software. The bilateral basal ganglia (BG) and occipital cortex (OC) on the same slide were selected as the ROI for PET/CT imaging. Maximum standard uptake values (SUVmax) of basal ganglia to occipital cortex (BG/OC) ratios were determined. The right hemisphere was used for the pathological examination and immunohistochemical staining of glucose transporters (GLUTs) and monocarboxylate transporters (MCTs). The left hemisphere was immediately frozen at -80ºC for western blotting.

RESULTS

The lactate level became reduced after an initial increase, with the maximal level occurring around 2-6 h following HI. After HI, the BG/OC in the basal ganglia initially increased then decreased; the maximum value occurred at approximately 6-12 h. The content of lactate and the BG/OC showed a positive correlation ($r = 0.74$, $P=0.003$). The expression of GLUT-1 and GLUT-3 correlated positively with BG/OC ($r = 0.64$, $P=0.014$, and $r = 0.75$, $P=0.036$, respectively).

CONCLUSION

These results indicate that lactate and glucose transporters have a synergistic effect on the energy metabolism of neurons and astrocytes following hypoxic-ischemic reperfusion brain injury.

CLINICAL RELEVANCE/APPLICATION

The HI model monitor the regulatory mechanisms of energy metabolism after HI.

SST09-05 3D Ultrasound Provides Accurate Tonsillar Volumes to Assess Hypertrophy

Friday, Dec. 1 11:10AM - 11:20AM Room: E350

Participants
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PURPOSE

Each year, there are millions of hospital visits in the United States for obstructive sleep apnea (OSA), a disease that is primarily caused by adenotonsillar hypertrophy. Adenotonsillectomy (T&A) is an effective solution for OSA and the second most common surgical intervention in the country. We investigated the ability of 3D ultrasound (3DUS) imaging with quantitative imaging analysis to safely, accurately and objectively assess tonsillar hypertrophy for the potential identification of candidates for adenotonsillectomy.

METHOD AND MATERIALS

A prospective study was performed evaluating patients (N=17) undergoing T&A for OSA symptoms ranging from 4-14 years with a mean of 7.8. Tonsillar imaging was performed by an attending radiologist using the Philips iU22 3DUS system with xMatrix probe. The volume and two principal axes (width and height) of the left and right tonsils were determined from 3DUS using ITKSnap software. The tonsils were then removed the same day in the operating room and immediately assessed by measuring the two principal axes of each tonsil using a Neiko 0417A Electronic Digital Caliper. The physical volume was then obtained by water submergence in a graduated cylinder. The findings from 3DUS and physical examination of the tonsils were compared using Bland-Altman analysis to determine their agreement (mean) and bias (mean+/-1.96 SD). Significance was assessed using the Wilcoxon signed-rank test.

RESULTS

The average tonsillar physical measurements of width and height were 20+/-3.2 mm and 27.23+/-41.4 mm, and 16.11+/-2.14 mm and 29.76+/-27.75 mm from 3DUS estimations, respectively ($p < 0.001$ for both). The average tonsillar volume was 3.84+/-1.23 ml and 4.29+/-1.14 ml from physical and 3DUS measurements, respectively ($p=0.09$). The Bland-Altman agreement +/- bias of the measured width, height, and volume results from the two measurements were -3.92+/-6.33 mm, 2.5+/-7.71 mm, and 0.45+/-2.32 ml, respectively.

CONCLUSION

We demonstrated the potential of 3DUS with quantitative imaging analysis to safely, accurately and objectively estimate tonsillar volume for assessing hypertrophy. 3DUS tonsil volumes were similar to physical measurements and more reliable than 2D measures of width and height.

CLINICAL RELEVANCE/APPLICATION

3DUS with quantitative imaging is an effective tool to objectively evaluate the tonsillar dimensions. This will allow for a more accurate selection for candidates for adenotonsillectomy.

SST09-06 What is the Optimal Needle Gauge and Injection Rate for Contrast Enhanced Ultrasound in the Evaluation of Therapeutically Cooled Neonatal Brains after Hypoxic Ischemic Injury?: Preliminary Data from an Experimental in Vitro Study

Friday, Dec. 1 11:20AM - 11:30AM Room: E350

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PURPOSE

Therapeutic hypothermia for hypoxic-ischemic encephalopathy (HIE) in neonates is used to reduce morbidity and mortality. However, optimum ultrasound (US) contrast delivery under therapeutic hypothermia is not well known. We aimed to quantify microbubble contrast intensity under these temperature conditions to determine optimal microbubble delivery.

METHOD AND MATERIALS

We injected Lumason® contrast agent into saline bags using 22 and 25-G needles under different injection rates: 0.1 mL/sec, 0.3 mL/sec, and 0.5 mL/sec. We performed injections at both 37ºC and 33.5ºC to reproduce normothermia and hypothermia conditions, respectively. We qualitatively evaluated for homogenous mixing and quantitatively assessed microbubble intensity with QLab US contrast quantification software installed on a Philips EPIQ scanner.

RESULTS

We found that 22-G needles yielded significantly higher peak intensities than 25-G needles ($p=0.0495$). Using 22-G needles, an injection rate of 0.3 mL/sec was optimal at 37ºC, and a rate of 0.5 mL/sec was optimal at 33.5ºC. There was no significant difference in the distribution of peak intensities between the two temperature groups using 22-G needles ($p=0.2752$). Using 25-G needles, an injection rate of 0.5 mL/sec was optimal at 37ºC, but at 33.5ºC no injection rate appeared most optimal. Additionally, using 25-G needles, the peak intensities at 37ºC were significantly higher than at 33.5ºC ($p=0.0495$).

CONCLUSION

The temperature reduction significantly impacted microbubble behavior, reducing the ability of the microbubbles to homogenously mix unless injected at a rate of 0.5 mL/sec. Additionally, 25-G needles increase microbubble destruction. Further study is needed to optimize contrast delivery under hypothermia conditions.

CLINICAL RELEVANCE/APPLICATION

Contrast enhanced ultrasound is valuable imaging modality in assessing brain injury in hypoxic-ischemic encephalopathy. Contrast delivery must be optimized under therapeutic cooling conditions.

SST09-07 Multispectral Data Analysis of Reduced FOV Diffusion Tensor Images of Pediatric Spinal Cord Injury

Friday, Dec. 1 11:30AM - 11:40AM Room: E350

Participants
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PURPOSE

A key challenge in the imaging of spinal cord injury (SCI) patients is the ability to accurately determine structural or functional

A key challenge in the imaging of spinal cord injury (SCI) patients is the ability to accurately determine structural or functional abnormality as well as level and severity of injury. Diffusion tensor imaging (DTI) allows the characterization of physical and functional properties of tissues. The purpose of this study is to assess quantitative multispectral texture (MST) features of diffusion tensor images and its potential clinical relevance in discriminating typically developing (TD) pediatric spinal cords and those with cervical spinal cord injury (SCI).

METHOD AND MATERIALS

A total of 15 subjects (10 TD and 5 cervical SCI patients) ranging in age from 6-16 yrs were recruited and scanned for DTI along cervical spinal cord using 3.0T Siemens Verio MR scanner. Initially, DTI images were corrected for motion induced artifacts and then robust estimation of tensor was used to generate DTI indices including fractional anisotropy (FA) and mean diffusivity (MD). Finally, 33 texture features were generated from both FA and MD maps. These features included 5 first order features (mean, variance, skewness, kurtosis and entropy), 16 second order feature vector elements calculated from grey level co-occurrence matrices (GLCM) in directions of 0°, 45°, 90° and 135° and 12 high order texture features generated from three different coefficients matrices in directions of horizontal (0°), vertical (45°), and diagonal (90°) of wavelet decomposition. These features then were compared between TD and cervical SCI subjects based on standard least squared linear regression model and restricted maximum likelihood method.

RESULTS

The experimental findings show that there are significant differences in texture values of FA and MD maps between TD and cervical SCI population. A total of 7 texture features from the FA map and 8 MST features from MD map showed statistically significant discrimination between TD and cervical SCI (tables1-3).

CONCLUSION

We have demonstrated experimentally that MST features have the potential for better discrimination of patients with SCI compared to the TD. MST features quantify macroscopic and also the microscopic abnormalities that may be undetectable using conventional DTI analysis.

CLINICAL RELEVANCE/APPLICATION

Texture descriptors could be used as quantitative imaging markers in addition to conventional MR imaging for the facilitation of diagnosis and characterization of the tissues in the pediatric spinal cord.

SST09-08 Radiologic Features of Posterior Reversible Encephalopathy Syndrome (PRES) After Hematopoietic Stem Cell Transplantation in Pediatric Patients

Friday, Dec. 1 11:40AM - 11:50AM Room: E350

Participants
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PURPOSE

To assess the incidence and imaging features of posterior reversible encephalopathy syndrome (PRES) in pediatric patients after hematopoietic stem cell transplantation (HSCT)

METHOD AND MATERIALS

This prospective study was conducted on all pediatric patients who underwent HSCT between March 2014 and June 2016. Brain CT scan was carried out in all patients who developed neurologic symptoms/signs followed by brain MRI. In those with diagnosis of PRES, follow-up MRI was conducted within two months. MRI was performed using a 1.5 Tesla magnet (Avanto, Siemens) including DWI and SWI sequences.

RESULTS

A total of 254 patients (160 males, mean age:7.6±4 years) underwent HSCT including 65 individuals with thalassemia, 41 with fanconi anemia, 59 with lymphoma/leukemia and 89 with other miscellaneous disorders. Brain MRI revealed PRES in 23 (9.1%). Seizure was the most common presenting symptom followed by headache. Patients with fanconi anemia were at greater risk of developing PRES compared to other diseases as PRES was seen in 9 out of 41 of patients with fanconi anemia (p value: 0.004). MRI showed asymmetric lesions in 10 patients of which, unilateral hemispheric involvement was noted in two patients . Superior frontal sulcus distribution was the most frequent imaging pattern (8/23, 34.8%) followed by holo-hemispheric (6/23, 26.1%), dominant posterior (6/23, 26.1%) and partial (3/23, 13%) distributions. Transient restricted diffusion was noted in one patient with unremarkable follow-up MRI. Microhemorrhagic foci were depicted In 4 patients. Of them, one patient died shortly after PRES. Follow-up MRI showed persistent microhemorhagic foci in the other three patients. Another patient with hemorrhagic PRES died later due to a second episode of PRES.

CONCLUSION

This study showed high incidence of PRES in children after HSCT especially in those with fanconi anemia. Various patterns of edema distribution is seen in brain MRI of pediatric population with PRES. Hemorrhagic PRES occurs in a minority of patients, which is possibly associated with worse prognosis.

CLINICAL RELEVANCE/APPLICATION

PRES shows various imaging patterns in pediatric patients following Hematopoietic stem cell transplantation; with microhemorrhagic

PRES shows various imaging patterns in pediatric patients following Hematopoietic stem cell transplantation, with microhemorragic PRES being probably associated with worse prognosis.

SST10

Physics (CT: Image Quality and Techniques)

Friday, Dec. 1 10:30AM - 12:00PM Room: E264

CT PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants

Xiaochuan Pan, PhD, Chicago, IL (*Moderator*) Research Grant, Koninklijke Philips NV ; Research Grant, Toshiba Medical Systems Corporation; Research Grant, Varian Medical Systems, Inc
Timothy P. Szczykutowicz, PhD, Madison, WI (*Moderator*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC

Sub-Events

SST10-01 Effect of Model-Based Iterative Reconstruction on Computer-Aided Detection for Quantitative Analysis of Airway Tree in Routine Dose Chest CT: Comparison with Adaptive Statistical Iterative Reconstruction

Friday, Dec. 1 10:30AM - 10:40AM Room: E264

Participants
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PURPOSE

The pulmonary airway display can reflect the image quality of the chest CT.this retrospective study comparative evaluation of model-based iterative reconstruction (MBIR),adaptive statistical iterative reconstruction (ASIR) with lung kernel on the performance of computer-aided detection (CAD) for quantitative analysis of airway in routine dose chest CT.

METHOD AND MATERIALS

30 patients were included who were scanned for pulmonary disease using a clinical routine dose MDCT system (Discovery CT750 HD,GE Healthcare).Data were reconstructed with MBIR,ASIR(40% ASIR and 60% FBP mix).Airway dimensions were measured from the two reconstructions using an automated, quantitative software that was designed to segment and quantify the bronchial tree, and a skeletonization algorithm to extract the center-line of airway trees automatically (Figure 1).For each patients and reconstruction algorithm chose the right middle lobe bronchus with the least tortuous and bifurcation as a representative to measure the bronchial length of the matched airways. Two radiologists used a semi-quantitative 5-point scale (from -2 for inferior to +2, for superior; -1 for slightly inferior to +1 slightly superior ; and 0, equal with ASIR) to rate subjective image quality of airway trees on the MBIR images.Using paired t and Wilcoxon signed-rank tests for comparison.

RESULTS

Algorithm impacted the measurement variability of the length of bronchus in routine dose chest CT,and MBIR was better,which produced longer bronchus than ASIR($P<0.05$) (Table 1, Figure 2). ($P<0.05$) (Table1,Figure 2).MBIR reconstructions also had higher subjective scores for the airway trees than ASIR($P<0.05$) (Table 2, Figure 3).

CONCLUSION

The quantification accuracy of airway is strongly influenced by reconstruction algorithm.The MBIR algorithm potentially allows the desired airway quantification accuracy to be achieved. which may enable a wider clinical use of low-dose Chest MDCT.

CLINICAL RELEVANCE/APPLICATION

Compare ASIR,MBIR algorithm potentially allows the desired airway quantification accuracy to be achieved on the performance of CAD in routine dose chest CT.which may be used to reduce radiation dose.

SST10-02 Optimization of Multi-Energy Non-Local-Means Denoising for Ultra High Resolution Photon Counting Detector CT Images

Friday, Dec. 1 10:40AM - 10:50AM Room: E264

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PURPOSE

Ultra-high-resolution (UHR) photon-counting-detector (PCD) CT has been shown to produce clinical images of unsurpassed spatial resolution, with slices as thin as 0.25 mm. However, the substantially increased noise of UHR images at these thin slices could potentially degrade diagnostic value. In this work, we investigated how to optimize noise reduction with an image based multi-energy, non-local-means (MENLM) method without loss of anatomical details.

METHOD AND MATERIALS

After IRB approval, UHR-PCD CT images of patients were obtained for different diagnostic tasks, including high resolution chest and musculoskeletal exams. MENLM was applied to the 0.25-mm thick filtered-back-projection (FBP) images for each case with variable filter strengths. Each denoised image was then combined with the original FBP image with variable blending ratios. 2D noise power spectra (NPS) were generated from a clinically relevant anatomic region within the patient anatomy. The optimal combination of FBP weighting and MENLM filtration was determined as the one producing the largest amount of image noise reduction without significantly shifting the NPS towards lower spatial frequencies. A board-certified radiologist reviewed all combinations of denoised images and ranked them for image noise, sharpness, presence of artifacts and overall diagnostic quality.

RESULTS

Approximately equal weighting between FBP and aggressively filtered MENLM-denoised images was shown to be the best compromise for the evaluated clinical tasks. For both exams, the radiologist assessment of image quality confirmed the selection based on NPS profiles. The images that were ranked with the highest overall diagnostic quality showed 40% noise reduction for the knee exam and upwards of 50% noise reduction for the chest exam, compared to the original FBP images. In both cases, denoised images received much higher scores in every aspect of image quality that was assessed.

CONCLUSION

NPS profiles computed directly from a relevant anatomic region provide a useful reference to guide a clinical task-specific optimization of denoising algorithms for UHR PCD CT images, allowing noise to be reduced by 40-50% without alteration of fine details or noise texture.

CLINICAL RELEVANCE/APPLICATION

Noise reduction algorithms can be limited by degradation of fine structures. Blending aggressively denoised images with the FBP data resulted in improved performance with preserved anatomical details.

SST10-03 Achieving Higher Image Quality at 75% Lower Dose with Model-Based Iterative Reconstruction in Abdominal CT

Friday, Dec. 1 10:50AM - 11:00AM Room: E264

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PURPOSE

To assess image quality of a model-based iterative reconstruction (MBIR) in lower-dose abdominal CT, in comparison with the filtered back projection (FBP) reconstruction with standard dose.

METHOD AND MATERIALS

This study was approved by ethics committee and written consent was provided by all patients. Twenty patients underwent (75%) lower dose contrast-enhanced abdominal CT and reconstructed with MBIR after routine-dose contrast-enhanced CT which was reconstructed with conventional FBP algorithm. Two radiologists assessed the images blindly per the sharpness, image noise, diagnostic acceptability and artifacts with 5-point scoring (1-5 points, Grade 1: cannot be used for diagnosis; Grade 2: poor; Grade 3: acceptable; Grade 4: good; Grade 5: very good). Image noise and signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of abdominal organs relative to abdominal fat were assessed. The volume CT dose index (CTDIvol), dose length product (DLP) and dose reduction rate were also obtained.

RESULTS

CTDIvol and DLP were 3.04±1.48mGy and 95.56±47.17mGy*cm for the lower-dose CT, 12.16±5.18mGy and 376.39±160.40mGy*cm for the routine-dose CT, respectively with 75% reduction (Table 1). Lower-dose MBIR images had significantly lower objective image noise (6.12±1.03HU), higher SNR (11.56±3.30) and CNR (26.96±5.88) than both the lower-dose (39.61±4.55HU, 2.03±0.41 and 4.75±0.98, respectively) and routine-dose (21.45±3.92HU, 3.79±0.68 and 9.01±1.90, respectively) FBP images (all $P<0.001$) (Table 2). In addition, MBIR had better subjective scores (4.20±0.77) than FBP (2.70±0.66 in routine-dose and 1.55±0.51 in lower-

dose) in noise, sharpness and artifacts (Fig. A-D).

CONCLUSION

The MBIR significantly improves the objective and subjective image quality in (75%) lower-dose abdominal CT scans, compared with the routine-dose FBP reconstructions.

CLINICAL RELEVANCE/APPLICATION

The MBIR significantly improves the objective and subjective image quality in (75%) lower-dose abdominal CT scans, compared with the routine-dose FBP reconstructions.

SST10-04 Combination of Dual Phase Acquisition and Snapshot Freeze Technique to Improve the Image Quality in Patients with Intermediate Heart-Rate

Friday, Dec. 1 11:00AM - 11:10AM Room: E264

Participants
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PURPOSE

To investigate the value of dual phase (45% and 75% of R-R interval) acquisition and snapshot freeze technique on the image quality of coronary computed tomographic angiography (CCTA) on patients with intermediate heart rate (70 to 80bpm), in comparison with single phase.

METHOD AND MATERIALS

Forty-six patients [28 men and 18 women; age (M±SD), 55.3 ± 8.0 years; body mass index (BMI) (M±SD), 25.20±2.8kg/m2] with intermediate heart rate (70 to 80bpm) were scanned on a 256-row detector CT scanner (Revolution CT, GE healthcare). The volume and flow rate of the contrast medium were adapted to the patient's body weight. The scanning range was 140mm or 160mm from the level of the tracheal bifurcation to the diaphragm. Dual phase (45% and 75% of R-R interval) acquisition was performed for all the patients. For both phases, snapshot freeze (SSF) and standard (STD) reconstructions were applied for each patient. Two experienced radiologists, who were blinded to reconstruction information, independently graded the CT images in terms of visibility and artifacts with likert 4-point score(1 = insufficient, 4 = excellent) on a per-patient- and a per-artery-base analysis.Image interpretability of 45%+75% of R-R interval was compared with single 45% and 75% of R-R interval with paired Chi-square test. Image score of 45%+75% of R-R interval was compared with 45% and 75% of R-R interval with signed rank sum test.

RESULTS

For STD reconstruction, dual phase showed higher interpretability than single 45% and 75% of R-R interval on per-artery level [84.8%(117/138) vs 62%(85/138) vs 67%(93/138),P<0.001], and on per-patient level [63%(29/46) vs 39%(18/46) vs 37%(17/46),P=0.021]. When combined with SSF reconstruction, image interpretability on per-artery level and per-patient level was further improved from [84.8%(117/138) and 63%(29/46)] to [96.4%(133/138) and 89.1%(41/46)]. The image quality score for dual phase was higher than single 45% and 75% of R-R interval on both per-artery level and per-patient level (both P<0.001).

CONCLUSION

Combination of dual phase (45% and 75% of R-R interval) acquisition and snapshot freeze technique could improve the image quality and interpretability of CCTA of patients with intermediate heart rate.

CLINICAL RELEVANCE/APPLICATION

Adequate selection of the cardiac phase with this SSF can provide acceptable diagnostic image in patients with an average 70<=HR<=80.

SST10-05 An Image Quality Assessment of the Noise Problem in Edge Preserving Regularization of Low-dose Statistical Iterative CT Image Reconstruction

Friday, Dec. 1 11:10AM - 11:20AM Room: E264

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PURPOSE

This report assesses a new regularization within the framework of statistical iterative image reconstruction in CT, which results in a more uniform noise distribution than other edge preserving regularizations.

METHOD AND MATERIALS

Iterative image reconstruction with edge preserving penalties in CT is known for noise reduction while recovering high spatial resolution and low contrast details. However, a preserved edge is also known to keep the surface around anatomic features noisier

than the surrounding flat areas, which may degrade diagnostic performance of an observer. The new coherent L1 norm reduces the dimensionality of the noise reduction close to the surface between the two tissues and performs noise reduction more uniformly across the entire volume, while keeping the advantage of high spatial resolution.

RESULTS

A medical doctor was asked to review 24 low dose CT abdomen cases, with each containing 4 images reconstructed using the new coherent L1 norm, total variation, Huber penalty and quadratic penalty regularizations. Special attention was paid to critical anatomy with known diseases, including stomach cancer, hemangioma, small cyst, cirrhosis, liver abscess, carcinoma, liver and pancreatic cancer. Total variation and Huber penalties produced images with rough edges, quadratic penalty produced images with low spatial resolution and coherent L1 norm images had both high spatial resolution and uniform noise performance, receiving the highest rating from the observer in all cases. A noise study was conducted on an analytic phantom with inserts of various contrast and image pixel noise variance was calculated for every voxel in the image. We compared the noise variation on the edge voxels and noise variation on the flat regions; the coherent L1 norm showed the least amount of difference on those regions of interest.

CONCLUSION

Coherent L1 norm substantially improves the edge appearance in the reconstructed image with preserved low-contrast details and high-contrast spatial resolution.

CLINICAL RELEVANCE/APPLICATION

Low-dose CT may result in images that have rough edges and leave a doubt with the physician about the condition of the patient. The main cause is the edge preserving regularization in CT reconstruction reduces the noise, but makes organ edges appear rough. Coherent L1 norm with its edge preserving and uniform noise reduction across the image volume has a potential to increase physicians diagnostic confidence.

SST10-06 The Application of Deep Learning Algorithm Pixel Shine in Arterial Phase Pelvic CT for Image Quality Improvement

Friday, Dec. 1 11:20AM - 11:30AM Room: E264

Participants
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PURPOSE

To assess the effect of a deep learning denoising algorithm, Pixel Shine (AlgoMedica, Inc, Sunnyvale, CA) on the quality of pelvic arterial phase CT images.

METHOD AND MATERIALS

A retrospective analysis was performed on arterial phase pelvic CT images from 33 patients (BMI<=20) obtained with a GE Revolution CT (70 kVp tube voltage, and ASIR-V-FBP 50% blending) and designated group A. Group B images were then obtained by applying Pixel Shine algorithm to group A image datasets. Subjective image quality was evaluated using a 5-point scoring system by two radiologists, and the scores of the groups were compared. Image signal was assessed using CT values of the urinary bladder. The CT and standard deviation (SD) values of the gluteus maximus were measured, and the SD values of the gluteus maximus were used to represent image noise. The signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of the bladder were then calculated. The image noise, SNR and CNR of two groups were compared using paired t-test.

RESULTS

The subjective visual image quality score of groups A and B, respectively, were 3.03±0.17 vs. 3.85±0.57, the image noise was 15.79±2.05 HU vs. 11.06±2.22 HU, the SNRs of bladder were 0.50±0.23 vs. 0.79±0.39, the CNRs of bladder were 3.72±0.85 vs. 5.14±1.27. Group B showed better subjective image quality, lower image noise, and improved SNR and CNR compared to group A; these differences were statistically significant ($p<0.05$).

CONCLUSION

Processing of arterial phase pelvic CT images reconstructed using ASIR-V technique by deep learning algorithm Pixel Shine significantly improved subjective image quality, reduced image noise, and increased SNR and CNR.

CLINICAL RELEVANCE/APPLICATION

Superior image quality and reduced image noise may be achieved by processing of low-dose ASIR-V reconstructed pelvic CT images using deep learning algorithm such as Pixel Shine.

SST10-07 Human Observer Performance for Localization of Liver Lesions: Correlation between Anatomical and Uniform Background

Friday, Dec. 1 11:30AM - 11:40AM Room: E264

Participants
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PURPOSE

To determine the correlation of human performance for localization of small low contrast lesions within uniform water background and within anatomical liver background under the conditions of varying dose, lesion size, and reconstruction algorithm.

METHOD AND MATERIALS

Liver lesions of 5, 7, and 9mm diameter (contrast -21HU) were digitally inserted into projection data of disease-free liver CT scans in regions free of major vessels. Noise was inserted into the full-dose projection data to create three image sets: full dose, simulated half dose, and simulated quarter dose. The images were reconstructed with a standard filtered back projection (FBP) and an iterative reconstruction (IR) algorithm. Lesion and noise insertion procedures were repeated for water phantom data at the same three dose levels. For each background, 2D regions of interest were selected, randomized, and independently reviewed by three medical physicists. Each region of interest had either one lesion present or no lesions present (66 lesion-present, 34 lesion-absent). The readers identified the most likely location of the lesion and provided a confidence score. The locations and confidence scores were assessed using the area under the localization receiver operating curve (AzLROC). We examined the correlation of human performance for the cases of uniform and liver backgrounds as dose level, lesion size, and reconstruction type varied.

RESULTS

As lesion size or dose increased, the readers' ability to locate the lesion improved. At full dose, the AzLROC for the 5, 7, and 9mm lesions in the liver background IR images were 0.53, 0.91, and 0.97, respectively. Similarly, the AzLROC in the uniform background IR images were 0.51, 0.96, and 0.99 for the 5, 7, and 9mm lesions. Similar trends were seen for the other dose levels. The performances between liver and uniform water backgrounds were highly correlated for both FBP and IR. For liver vs. uniform background, the average difference in AzLROC was 0.03±0.03 and had a Spearman correlation of ρ=0.97.

CONCLUSION

For the task of localizing low contrast liver lesions, human observer performance was highly correlated between anatomical and uniform backgrounds.

CLINICAL RELEVANCE/APPLICATION

Liver lesion localization studies may use uniform or anatomic backgrounds, as similar and highly correlated human performances were seen between uniform and liver backgrounds.

SST10-08 Quantifying Quality: Correlating Phantom and Clinical Scan CT Noise Levels to Construct a Quality Reference Level

Friday, Dec. 1 11:40AM - 11:50AM Room: E264

Participants
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CONCLUSION

This study represents a proof of concept method to develop and refine a Noise Reference Level for a given protocol and scanner. This represents a first step in establishing an automated Performance Reference Level for a given scan protocol that incorporates both radiation dose and image quality.

Background

The use of ionizing radiation in computerized tomography mandates risk-benefit understanding. However, this consideration may weight the presumed risk of the ionizing radiation at the expense of the benefits of the examination, with protocol optimization often focusing on dose reduction to the potential detriment of image quality, hence diagnostic value. In fact, the standardized Diagnostic Reference Levels (DRL) are based solely on dose metrics. The purpose of this study is to begin to systematically evaluate an efficient tool for image quality, an automated noise metric in CT to eventually develop a performance metric consisting of both radiation dose and image quality.

Evaluation

Using an IRB-exempt protocol, automated noise values were determined for 1904 contrast enhanced abdominopelvic (AP) and unenhanced chest CT scans on two different scanner models. These data were used to calculate a Noise Reference Level (NRL) by calculating a noise median across a 25-35 cm patient size range, defining the NRL as this median ±20%. A variable diameter phantom was also scanned utilizing both protocols on both scanners, and the resultant noise-size curves for the phantom were compared to those utilizing clinical scan data.

Discussion

Utilizing our novel noise evaluation tool, noise-patient size curves demonstrate agreement between clinical scan and phantom data. Noise measurements were varied based on the region scanned, with the NRL interval between 25 and 37 HU for AP CT, and between 10 and 15 HU for chest CT. This demonstrates the utility of noise monitoring across large numbers of scans to generate a target noise range based on region scanned and scanner equipment, and to identify and evaluate image quality outliers. This automated tool can thus be used to compare performance in a single scanner and between scanners for similar sized patients independent of interpreting radiologist subjective biases.

SST10-09 Quantification of Ellipticity Ratios for Head, Shoulders, Chest, and Abdomen and Their Impact on AEC in CT

Friday, Dec. 1 11:50AM - 12:00PM Room: E264

Participants
Timothy P. Szczykutowicz, PhD, Madison, WI (*Presenter*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC
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PURPOSE

It has been reported that CT scanner automatic exposure control (AEC) systems consider patient ellipticity ratio when setting the dose level. In other words, two patients of identical water equivalent diameter (WED) would receive different doses if their ellipticity ratio differed. Because of this effect, understanding large aggregate dose datasets where one plots WED against dose requires incorporation of patient ellipticity ratio to fully predict and model a scanner AEC response.

METHOD AND MATERIALS

We analyzed 884 patient CT scans under IRB approval. The average effective mAs, WED, and ellipticity ratio were calculated for each patient's scan. Data from routine head, chest, ad abdomen/pelvis scans was included for both adults and pediatrics. These datasets were further broken into specific body regions corresponding to: head, chest, shoulders, thorax, abdomen, and abdomen/pelvis. We measured the ellipticity ratio by taking the ratio of the lateral to anterior-posterior patient dimension for each body region. We developed a theoretical model for the CT scanner's AEC function that includes parameters for angular tube current modulation, WED based dose compensation, and ellipticity based dose compensation. We applied the model to fit a dataset containing 294 adult abdomen/pelvis exams under IRB approval.

RESULTS

As expected, the ellipticity ratio of the shoulder region was the highest at 2.28+/- 0.22. The abdomen/pelvis, chest, thorax, and abdomen regions all had ellipticity values near 1.5. The adult head had an ellipticity value of 0.85 +/- 0.08. Our AEC model predicted changes in effective mAs for a given WED as a function of ellipticity as desired. We noted that issues due to patient truncation and the presence of metal implants caused our model to fail. The former is understandable as a truncated image produces a WED smaller than what the AEC systems assumed. Interestingly, the presence of metal orthopedics caused an increase in WED but not a corresponding increase in effective mAs.

CONCLUSION

We measured and showed why patient ellipticity is important in understanding the function of a CT scanner's AEC system.

CLINICAL RELEVANCE/APPLICATION

AEC systems are complex and take into consideration more than just the patient size in terms of WED. We report on and model how ellipticity of a patient influences the output of a CT scanner.

SST11

Vascular Interventional (PAD)

Friday, Dec. 1 10:30AM - 12:00PM Room: E352

IR MR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Gordon McLennan, MD, Chagrin Falls, OH (*Moderator*) Research Grant, Siemens AG; Research Consultant, Medtronic plc; Advisory Board, Siemens AG; Advisory Board, Surefire Medical, Inc; Advisory Board, Stealth Medical; Advisory Board, Rene Medical; Data Safety Monitoring Board, B. Braun Melsungen AG
Charles Martin III, MD, Pepper Pike, OH (*Moderator*) Scientific Advisory Board, Boston Scientific Corporation

Sub-Events

SST11-01 MR Angiography in Small Animals Using Hyperpolarized Water

Friday, Dec. 1 10:30AM - 10:40AM Room: E352

Participants
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PURPOSE

The administration of Gadolinium based contrast agents is associated with the risk of allergic reactions and the development of a systemic nephrogenic fibrosis (NSF). Current research showed remnants of some types of Gadolinium based MR contrast agents in the brain - with unknown long-term effects. Purpose of our work is to examine dynamic nuclear polarization (DNP) as an alternative method for MR angiography.

METHOD AND MATERIALS

The used liquid-state Overhauser DNP is a technique to achieve hyperpolarization by microwave irradiation of electron spins in TEMPOL radicals, which are coupled with the nuclear spins of water molecules. Our setup comprises a 42 GHz microwave source and a 1.5 T in-bore DNP MRI polarizer, equipped with a multimode resonator. The continuously hyperpolarized water was administered with a flow of 1.2 ml/min into the aorta of five C57BL/6 mice via catheterization (0.15 mm ID) through iliac vessels. The aorta and its branches were visualized with GRE-sequences (TR 110s, TE 3.8s, FoV 78x58x2 mm, Matrix 256x192 px) and intravascular DNP signal intensities, SNR and CNR values were measured and compared to its native values.

RESULTS

Maximum intravascular signal intensities were increased 4.3-fold from 231±47 to 994±194 by infusion of hyperpolarized water. Thus better SNR and CNR values were measured for hyperpolarized vessels with an SNR increased 5.3-fold from 24±2 to 126±62 and CNR increased 26.3-fold from 3±2 to 79±49.

CONCLUSION

The used in-bore DNP setup continuously creates hyperpolarized water, which features high T1 signal enhancements in MR imaging and a short relaxation time. In our mice experiments the strong enhancement and its high CNR made a visualization of the aorta and its branches possible - even using a standard clinical 1.5 T scanner.

CLINICAL RELEVANCE/APPLICATION

Hyperpolarized water might be a promising future alternative to Gadolinium based contrast agents in MR angiographies without risking the potential adverse effects or intracorporal remnants of Gadolinium based contrast agents.

SST11-02 Type 2 Diabetes is Related to Increased Carotid Plaque Inflammation: A Novel Finding of Dynamic Contrast-Enhanced MR Imaging

Friday, Dec. 1 10:40AM - 10:50AM Room: E352

Participants
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PURPOSE

Although many pathological study have demonstrated that more microvessels and macrophages which associated with increased inflammation was exhibit in diabetic plaques, in vivo study of carotid plaque inflammtion in type 2 diabetes mellitus(T2DM) with dynamic contrast-enhanced (DCE) magnetic resonance (MR) imaging is rare. Thus our study aim to evaluate carotid plaque inflammation in stroke patients with and those without type 2 diabetes(T2DM) and to determine which risk factors might be associated with plaque inflammation in T2DM subjects.

METHOD AND MATERIALS

A total of 55 patients(25 T2DM and 30 non-T2DM) with carotid plaque ipsilateral to ischemic event were underwent bilateral carotid artery MRI examination. Multicontrast sequences for characterizing plaque morphologic and DCE MR images for assessing atherosclerotic plaque inflammation were obtained in T2DM and non-T2DM patients.

RESULTS

Compared with non-T2DM patients, patients with T2DM had more severe inflammtion, as evidenced by higher Ktrans(transfer constant) (0.099 vs 0.061, P=0.005). Compared with well controlled diabetes(Hemoglobin A1c[HbA1c] <7%), poorly controlled diabetes(HbA1c >=7%) also have increased inflammation, as evidenced by higher Ktrans (0.126 vs 0.074±; P=0.009) and ve (extracellular extravascular volume fraction) (2.301% vs 6.187%; P=0.026). HbA1c level was independently associated with Ktrans in overall patients and T2DM patients after adjusting for plaque characterization and comprehensive confounding factors.

CONCLUSION

This study demonstrated an increased plaque inflammation in T2DM patients and poorly controlled T2DM patients. There have an independent pathophysiological link between the HbA1c level and Ktrans. Thus, DCE-MRI may be useful in monitoring the efficacy of some anti-hyperglycemic agents on atherosclerotic plaque inflammation in T2DM patients.

CLINICAL RELEVANCE/APPLICATION

Thus, this in vivo plaque inflammation imaging may potentially useful in providing a clinical tool to better understand the role of inflammation and angiogenesis in plaque progression/regression, and to monitor and predict therapeutic response to inflammation-targeted pharmacotherapy.

SST11-03 Comparison of [18F] FDG-PET/CT and 3D-Black-Blood 3T-MRI for the Diagnosis of Large Vessel Vasculitis

Friday, Dec. 1 10:50AM - 11:00AM Room: E352

Participants
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PURPOSE

To investigate the concordance of a high-resolution three-dimensional (3D) black-blood turbo spin echo (TSE) MRI sequence with variable flip angles and [18F]FDG-PET/CT for the diagnosis of large vessel vasculitis (LVV).

METHOD AND MATERIALS

24 consecutive patients with suspected LVV who underwent 3D-black-blood 3T-MRI and [18F]FDG-PET/CT imaging between 2013 and 2016 in our center were retrospectively reviewed. For image analysis 11 different vessel segments were evaluated in both modalities. The MRI-slides were analyzed for signs of vessel wall inflammation, which are concentric contrast enhancement (CCE) and concentric wall thickening (CWT) as well as image quality (IQ) and flow artifact intensity (FAI), using 4-point Likert scales. [18F]FDG-PET/CT analysis comprised qualitative, quantitative and semiquantitative methods. [18F]FDG uptake was analyzed in patients with and without immunosuppressive medication. Imaging findings were correlated with the final clinical diagnosis for each diagnostic method.

RESULTS

In 19 of 24 patients (79%), active or inactive LVV was confirmed by clinical follow-up. 3T-MRI was positive in 17 patients, while [18F]FDG-PET/CT identified vasculitis in 14 patients. On MRI, 72% of vessel segments showed no or only minor flow artifacts and 82% disposed an excellent or good IQ (82.2%). Among the patients with LVV, the frequency of CWT and CCE was comparable (62.5% vs. 63.1%) and both parameters showed high correlation (Spearman`s R = 0.933; P<0.001). The subgroup analysis of patients with anti-inflammatory medication revealed no statistical difference regarding the results of the [18F]FDG-PET/CT examination.

CONCLUSION

Free breathing navigated black-blood MRI and [18F]FDG-PET/CT are promising imaging tools in diagnosing patients with LVV.

CLINICAL RELEVANCE/APPLICATION

3D-black-blood 3T-MRI could be a future radiation-free alternative to PET-CT for the diagnosis and follow-up of patients with LVV,

especially in young patients.

SST11-04 Correlation of the Potential Biomarker for Ascending Aortic Aneurysms, MMP-9 with Quantitative Flow Parameters Measured by 4D Flow MRI

Friday, Dec. 1 11:00AM - 11:10AM Room: E352

Participants
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PURPOSE

This translational study intends to evaluate if MMP-9, a matrix metallopeptidase involved in the degradation of extracellular matrix, in the serum of patients with thoracic aortic aneurysms (TAAs) could be used as potential biomarker for TAAs in the future. Therefore MMP-9 serum levels were correlated with quantitative hemodynamic flow parameters measured by 4D flow MRI.

METHOD AND MATERIALS

16 patients (age 56±13years) with aortic root/ascending aortic aneurysms >45mm underwent 4D flow MRI. Flow quantification was performed using ECG gated three-directional velocity encoding with full 3D coverage of the thoracic aorta. 4D flow MRIs were acquired in a sagittal oblique 3D volume using a flip angle of 8°, VENC: 150 cm/s, spatial resolution = (2.0-2,4)³mm³, and temporal resolution: 20-40 ms. Data analysis included 3D blood flow visualization (EnSight, CEI, USA) based on 3D particle traces and 3D streamlines. Time-resolved 2D data was extracted on a plane. The diameter, mean wall shear stress magnitude (meanWSSmag), 3D oscillatory shear index (OSI 3D) and percentage of retrograde flow were derived. MMP-9 levels in blood samples of these 16 patients were identified by ELISA tests. Patients were divided into two groups; Group A with bicuspid aortic valves (5 patients), Group B with tricuspid aortic valves (11 patients).

RESULTS

The following differences and correlations were shown in Groups A and B: MMP-9 levels were significantly higher in patients with BAV (Group A: 645.4(±203.9)ng/ml; Group B: 393.7(±129.1)ng/ml; +64%; p-value <0.05). Furthermore, within each group exist high correlations between MMP-9 levels and both meanWSSmag (Group A: r=0.74; Group B: r=0.5) and percentage of retrograde flow (Group A: r=0.69; Group B: r=0.5). There was also found to be a high negative correlation between MMP-9 and OSI 3D in Group B (r=0.54). The biggest diameters correlate in Group B to MMP-9 levels (r=0.54). No correlation was found for both of these parameters in Group A.

CONCLUSION

These results revealed a high correlation between quantifiable blood flow within TAAs and MMP-9. Further studies are warranted to investigate the influence of specific aneurysmatic blood circulation on the aortic wall and if MMP-9 can be used as potential biomarker for TAAs.

CLINICAL RELEVANCE/APPLICATION

MMP-9 could be used as an easy to gain biomarker for TAAs in the future. This would simplify the diagnosis.

SST11-05 Diagnostic Efficacy of Free-Breathing Contrast-Enhanced T1 Gradient Echo Sequences Compared to Standard Breath-Hold T1 Gradient Echo Sequences in the Assessment of Thoraco-Abdominal Aorta Having CT Angiography as Standard of Reference

Friday, Dec. 1 11:10AM - 11:20AM Room: E352

Participants
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PURPOSE

To evaluate the diagnostic accuracy of contrast-enhanced T1 free-breathing gradient echo sequences in the evaluation of aortic disease, in comparison with standard MR-angiographic sequences and CT-angiography studies.

METHOD AND MATERIALS

Fifty-three patients, with known aortic disease at CT-angiography evaluation, were prospectively evaluated with a 1.5T magnet (Achieva,Philips), with a phased array multi-coil, after the intravenous injection of 0.1 mL*Kg of gadobutrol. A standard MR angiography examination was performed with 3D-angiographic sequences and T1 breath-hold sequences (THRIVE). Multiplanar T1 free-breathing gradient-echo fat-suppressed (THRIVE-FB) sequences were additionally performed in all the examinations. Two radiologists independently compared the diagnostic quality of MR-angiographic sequences and CT-angiography studies, in terms of visualization of aortic wall and lumen and main arterial branches. Vascular calipers measured at different aortic levels were compared between the MR-sequences and CT evaluations and statistically analyzed. The interobserver agreement was investigated using the Intraclass Correlation Coefficient (ICC).

RESULTS

Free breathing sequences showed good diagnostic accuracy in the assessment of vascular calipers, with no significant differences compared to standard breath-hold MR-sequences and CT-studies. THRIVE-FB also demonstrated high sensitivity and specificity in the evaluation of vascular wall, plaques, thrombus and adjacent structures. Not significant differences were obtained in terms of diagnostic quality, between THRIVE-FB sequences, standard angiographic sequences and CT-angiography, with a good interobserver agreement (ICC of 0.85).

CONCLUSION

Free-breathing contrast-enhanced T1 gradient-echo fat-suppressed sequences, combined with high relaxivity contrast agent, demonstrated high diagnostic efficacy, permitting to correctly evaluate the aorta and its major branches, with no significant differences in comparison with standard breath-hold MR-sequences and CT studies.

CLINICAL RELEVANCE/APPLICATION

Angiographic free-breathing sequences may represent a useful tool in not-compliant patients, allowing to correctly evaluate main thoraco-abdominal arteries, with good diagnostic quality images.

SST11-06 Computed Tomography Guided Lumbar Sympathectomy (CTLS) as a Palliative Treatment in Patients with Critical Limb Ischemia Not Amenable to Therapeutic Revascularization

Friday, Dec. 1 11:20AM - 11:30AM Room: E352

Participants
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PURPOSE

To evaluate the safety and efficacy of CTLS in the management of patients of critical limb ischemia without revascularization optionsTo assess the effects of technical parameters of CTLS on the clinical success of the procedure

METHOD AND MATERIALS

Patients with critical limb ischemia with angiographic anatomy not amenable for revascularization were included in the study. Exclusion criteria were patients not giving consent, unable to lay prone and deranged coagulation parameters. CTLS was performed with patient in prone position using 22 G chiba needle at L1-L3 vertebral level with a mixture of neurolytic solution (99% alcohol) and non-ionic contrast in the ratio of 10:1 after confirming the spread with a check solution of diluted contrast. Patients were observed for 4 hours before discharge. Periprocedural complications were noted; Numerical pain score (NPS) and limb changes were assessed before and after the procedure at 3 weeks and 3 months. Spread of neurolytic mixture was categorised as medial or lateral with respect to lateral edge of vertebral body. Treatment results were categorized into improved, unchanged or worsened.

RESULTS

22 patients (19 males, 3 females) with mean age 45.3 years (range: 25-78 years) were included. Bilateral procedure was done in 19 patients and unilateral in 3 patients. The mean volume of absolute alcohol injected per side was 7.5 mL. No procedure related complications were noted. 18 (81.8%) patients improved and 4 patients (18.2%) were unchanged. The mean NPS pre-procedure, 3 weeks and 3 months post procedure were 6.82, 3.32 and 3.05 respectively.($p<0.0001$). Pain relief was significantly better in patients with medial spread of the neurolytic agent compared to those without medial spread ($p=0.027$). Interestingly, 7/16(43.75%) patients reported ulcer healing in 3 months follow up.

CONCLUSION

CTLS is a simple, safe and effective procedure in patients with critical limb ischemia due to infragenicular diffuse arterial disease. Medial spread of the neurolytic agent provides significantly better results.

CLINICAL RELEVANCE/APPLICATION

CT guidance is optimal for exact needle positioning to achieve medial spread of neurolytic mixture which gives better results as seen in this study. CTLS helps in ulcer healing especially in patients with buergers disease who quit smoking since it provides pain relief and helps in opening collateral vessels via chemical sympatheticolysis.

SST11-07 String-Like Lumen in Below-the-Knee Chronic Total Occlusions on Contrast-Enhanced Magnetic Resonance Angiography Predicts Intraluminal Recanalization and Better Blood Flow Restoration

Friday, Dec. 1 11:30AM - 11:40AM Room: E352

Participants
Yingsheng Cheng, MD, Shanghai, China (*Presenter*) Nothing to Disclose

CONCLUSION

In patients with BTK CTOs, SL predicted intraluminal angioplasty and good blood-flow restoration for BTK CTOs.

Background

To determine whether string-like lumina (SLs) on contrast-enhanced magnetic resonance angiography (CE-MRA) predict better outcomes in diabetic patients with below-the-knee (BTK) chronic total occlusions (CTOs)

Evaluation

This study involved 317 long-segment (>5cm) BTK CTOs of 245 patients that were examined using CE-MRA and treated using endovascular angioplasty. A SL with a CTO was slowly filled with blood on conventional CE-MRA. SL-positive CTOs (n=60) achieved a higher technique success rate, preferred intraluminal angioplasty and better blood flow restoration than SL-negative CTOs (n=257 P<0.05). Multivariate analyses revealed that lesion length was the independent predictor of procedural success (P=0.028). SL was a predictor of intraluminal angioplasty (P<0.001) and good blood-flow restoration (P=0.004). Kaplan-Meier analyses at 12 months revealed a higher target lesion patency rate (P=0.04) and limb-salvage rate (P=0.35) in SL-positive CTOs.

Discussion

Our main findings are as follows: (1) intraluminal recanalization was more frequently used for BTK CTOs with SLs than without SLs; (2) CTO length was the only independent predictor of successful CTO recanalization; (3) SL was the only predictor of intraluminal angioplasty in the BTK CTOs; (4) SL and CTO length were predictors of good blood-flow restoration after recanalization; and (5) restenosis-free and limb-salvage rates were better for SL-positive CTOs than SL-negative CTOs.

SST11-08 Ultrasound-Guided Percutaneous Thrombin Injection for the Treatment of Iatrogenic Femoral Pseudoaneurysms

Friday, Dec. 1 11:40AM - 11:50AM Room: E352

Participants
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PURPOSE

To evaluate clinical and imaging factors that may affect successful ultrasound-guided percutaneous thrombin injection of iatrogenic femoral artery pseudoaneurysms.

METHOD AND MATERIALS

This was an IRB approved, HIPAA compliant retrospective study. The study population consisted of 326 consecutive subjects (138 males, 188 females; mean age 68 years, range 18 - 95 years) who underwent ultrasound guided percutaneous thrombin injection for the treatment of an iatrogenic femoral artery pseudoaneurysm. The number of pseudoaneurysm lobes, longest dimension, and volume of thrombin injected was recorded along with pre-procedure laboratory values of international normalized ratio (INR), activated partial thromboplastin time (aPTT) and platelet count. A follow up ultrasound was available in 146 subjects.

RESULTS

Technical success was achieved in 99.4% (324/326) of subjects. Technique efficacy, as measured by complete thrombosis on a follow up ultrasound, was achieved in 87.0% (127/146) of subjects. In 68% (13/19) of subjects who had not achieved complete thrombosis on follow up ultrasound, repeat thrombin injection was performed and deemed successful; 3 subjects required operative intervention and 3 subjects underwent no subsequent intervention. No imaging or procedure factor was associated with technique failure, including volume of thrombin injected (mean 476 units for complete thrombosis (CT) vs. 671 units for incomplete thrombosis (IT); p=0.105), number of pseudoaneurysm lobes (mean 1.33 for CT vs. 1.37 for IT; p=0.826) or largest size of pseudoaneurysm (mean 3.0 cm for CT vs. 3.6 cm for IT; p=0.133). No statistically significant difference in pre-procedure INR, aPTT or platelet count was found between subjects with CT and those with IT (p>0.125).

CONCLUSION

Imaging guided percutaneous thrombin injection has a high technical success rate for the treatment of iatrogenic femoral artery pseudoaneurysm. No imaging, procedure or laboratory factors are predictive of technique failure.

CLINICAL RELEVANCE/APPLICATION

Abnormal coagulation parameters do not affect technique efficacy for imaging guided percutaneous thrombin injection of iatrogenic femoral artery pseudoaneurysms.

SST11-09 Nephroprotective Imaging for Evaluation of Peripheral Arterial Occlusive Disease (PAOD): A Multi-Observer Comparison Study between Quiescent-Interval Single-Shot MR Angiography (QISS-MRA) and Invasive Angiography with Carbon Dioxide (CO2-DSA)

Friday, Dec. 1 11:50AM - 12:00PM Room: E352

Awards
Student Travel Stipend Award

Participants
Christophe Arendt, MD, Frankfurt Am Main, Germany (*Presenter*) Nothing to Disclose
Doris Leithner, MD, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
Lukas Lenga, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose
Rouben Czwikla, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
Julian L. Wichmann, MD, Frankfurt, Germany (*Abstract Co-Author*) Speaker, General Electric Company; Speaker, Siemens AG
Tatjana Gruber-Rouh, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Non-contrast QISS-MRA and CO2-DSA remain promising nephroprotective methods for accurate staging of PAOD in patients with chronic renal failure (CRF). The aim of our study was to assess the diagnostic value and subjective image quality of QISS-MRA in comparison with CO2-DSA.

METHOD AND MATERIALS

Sixteen consecutive patients (77.5±12.6 years, 64% male) with impaired renal function (eGFR 23.9±7.9 ml/min/1.73 m²) who underwent QISS-MRA at 3 Tesla and CO2-DSA within two weeks were retrospectively included. Identification of significant (>=50%) stenoses of the lower extremity arteries (21-segment-model) was evaluated by 4 independent readers with different level of experience per-segment in random order. Subjective image quality was determined using a 5-point Likert scale (1, non-diagnostic quality; 5, excellent quality or non-perceivable artifacts). CO2-DSA of an experienced interventional radiologist was considered the standard reference method.

RESULTS

115 segments were available for direct MRA-DSA comparison with a prevalence of >=50% stenoses of 27.8% (32/115). Diagnostic parameters of QISS-MRA yielded as follows: sensitivity 90.6% [95%CI: 84.2-95.1%], specificity 94.0% [95%CI: 90.9-96.3%], PPV 85.3% [95%CI: 79.1-89.9%], NPV 96.3% [95%CI: 93.8-97.8%], with an ICC of 0.89. Median values of qualitative imaging parameters for QISS-MRA were as follows: arterial signal intensity: 4 (pelvis), 4 (thigh), 5 (calf); venous overlay: 4, 4, 5; susceptibility artifacts: 5, 5, 5; motion artifacts: 4, 5, 5; ECG-related artifacts: 5, 5, 5. Values for ICC were 0.72, 0.73, 0.93, 0.69 and 0.79, respectively. Opacification of arteries at CO2-DSA was rated 3, 4, 3, with an ICC of 0.65.

CONCLUSION

Non-invasive QISS-MRA offers high diagnostic performance for the detection and ruling out of PAOD in comparison with invasive CO2-DSA. In a direct comparison, image quality of QISS-MRA was prefered by observers over CO2-DSA.

CLINICAL RELEVANCE/APPLICATION

Patients with symptomatic PAOD and CRF could undergo a non-invasive diagnostic evaluation of the lower extremities using QISS-MRA with subsequent guidance to vessels of interest for percutaneous intervention in DSA-technique.